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EFFECTS OF WATER LEVELS ON PRODUCTIVITY OF CANADA GEESE IN THE NORTHERN FLATHEAD VALLEY

Final Report

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EFFECTS OF WATER LEVELS ON PRODUCTIVITY OF CANADA GEESE IN THE NORTHERN FLATHEAD VALLEY

FINAL REPORT

Prepared by

Daniel Casey, Wildlife Biologist
and
Marilyn Wood, Wildlife Biologist
Montana Department of Fish, Wildlife and Parks
P.O. Box 67
Kalispell, MT 59903

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ABSTRACT

The Fish and Wildlife Program of the Northwest Power Planning Council calls for wildlife mitigation at hydroelectric projects in the Columbia River System. Beginning April, 1984, the Bonneville Power Administration funded a study (BPA Proj. No. 83-498) of the effects of the operation of Hungry Horse and Kerr Dams on the western Canada goose (*Branta canadensis moffittii*) inhabitating the Flathead Valley of northwest Montana. The study was conducted by personnel of the Montana Department of Fish Wildlife and Parks (MDFWP), to: 1) identify the size and productivity of this population, 2) identify current habitat conditions and losses of nesting and brood-rearing areas, 3) describe the effects of water level fluctuations on nesting and brood-rearing, and 4) identify mitigation alternatives to offset these effects.

Annual pair and nest surveys were used to document the location and fate of goose nests. The number of known nesting attempts varied from 44 in 1984 to 108 in 1985, to 136 in 1986 and 134 in 1987. Fifty-four percent of the annual nesting effort took place on elevated sites which were secure from the flooding and dewatering effects of fluctuating water levels. An average of 15 nests were found on stumps in the remnant Flathead River delta, however, an area strongly influenced by the operation of Kerr Dam. Annual nest losses to flooding and predation attributable to fluctuations caused by the dam were recorded. Nest success ranged from 58 to 81 percent over the study period, with predation being the primary cause of nest failure. Ten percent of river island ground nests failed due to flooding, but all occurred during periods of peak annual runoff. Nest success was lowest for marsh ground nests (39 percent) and highest for tree nests (88 percent).

Aerial surveys, radio-telemetry and activity budget surveys were used to document gosling production, survival, brood movements and habitat use in relation to water level fluctuations. The annual average production was more than 400 goslings. Nine important brood-rearing areas were identified. Eight of these were off-river sites in areas where daily water level fluctuations do not occur, and where seasonal fluctuations are minimal. The Flathead Waterfowl Production Area (WPA) on the north shore of Flathead Lake received the greatest use by broods, and was important as a year-round security area. During the brood-rearing period, extensive mudflat separated the lake from upland vegetation. Activity budget data indicated that broods in that area must therefore travel and feed more to meet their energy requirements. No resultant effect on gosling survival could be verified. Geese have benefitted from the invasion of *Butomus umbellatus* into the mudflat zone. This exotic emergent plant was heavily used by broods.

Review of aerial photos revealed large-scale losses of important waterfowl habitat on the north shore of the lake (1,859

acres) and along the river above the lake (235-273 acres) have occurred since the construction of Kerr Dam. Most of the acreage lost was valuable as nesting habitat (a delta of 400t acres, 600t acres of deciduous forest), or as brood-rearing habitat (approximately 1,300+ acres of herbaceous cover types). Two small islands used traditionally for nesting were lost completely during the four years of the study due to erosion during the extended full pool period characteristic of current Kerr Dam operation. Stumps used for nesting were lost at a 33-89 percent annual rate, and all stumps will be gone within ten years at the estimated rate of 13 percent per year. A minimum of 22 secure nest sites, representing 16 percent of the population in this portion of the Flathead Valley, will have been lost due to dam operation within ten years.

The results of the study indicate that Hungry Horse Dam has little effect on geese nesting downstream. Abnormally low flows rarely occur as a result of the dam's operation during the goose nesting period. Operation of the dam for flood control may actually prevent nest failure in some years. The operation of Kerr Dam, on the other hand, has caused extensive habitat losses, lowered nesting success and decreased availability of nest sites and brood-rearing habitat. Mitigation alternatives which were recommended included the construction of a subimpoundment with islands on the north shore, which would decrease erosion, provide nesting and brood-rearing habitat, and increase production. Nest structures could be provided to offset nest site losses and improve nest success. Future management and/or mitigation should focus on the nesting and brood-rearing areas identified during this study.

ACKNOWLEDGMENTS

We are indebted to Dr. I.J. Ball of the Montana Cooperative Wildlife Research Unit, University of Montana, for providing the impetus and continued technical advice which made this project possible. We also wish to thank him for arranging the many student volunteers who assisted in nest search efforts. We thank Shari Gregory, Dennis Mackey and Bill Matthews, biologists for the Confederated Salish and Kootenai Tribes, for their cooperation and technical assistance. Without Kristi Dubois and Cindy Conroy, who put in long valuable hours as Research Aides, a study of this scope would not have been possible.

Chet Severson, Jack Archibald, and especially Dave Hoerner, our pilots, provided us with the many technically demanding yet safe hours of aerial surveys essential to our study. We also wish to thank Ray Washtak and other U.S. Fish and Wildlife Service personnel at the National Bison Range and the Creston National Fish Hatchery for providing survey data, equipment and personnel for trapping, consultation, and access to the Flathead Waterfowl Production Area. Ron Mellem and other USFS personnel in Kalispell deserve thanks for their help with digitizing and the loan of a clinometer for habitat measurements. Beth Sorenson provided the captive geese for our egg-floating experiment, and we thank her for her gallant efforts fending off the gander in order to collect those important data. Other Flathead Valley residents, too numerous to mention individually, provided us with access to study sites, and information on past and present nesting efforts and habitat conditions. We thank them for their cooperation. We especially thank Jean Blair, Dennice Hamman Alice Martin, and Fran Silva for their word processing and administrative assistance throughout the course of this study.

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INTRODUCTION

The Columbia River Basin Fish and Wildlife Program was developed by the Northwest Power Planning Council in 1982, in response to the Pacific Northwest Electric Power Planning and Conservation Act of 1980. The Program includes measures to protect, mitigate, and enhance fish and wildlife resources affected by the development, operation, and management of hydroelectric facilities on the Columbia River and its tributaries. It specifically calls for evaluation of effects on wildlife and wildlife habitat attributable to both Hungry Horse and Kerr dams and development of mitigation plans to offset these effects. This study (BPA Project 83-498) was designed to address the effects of these projects on the western Canada goose (*Branta canadensis moffitti*) population inhabiting the northern portion of the Flathead Valley in northwest Montana, and was based on the following concerns expressed in Section 1000, Table 7 of the Fish and Wildlife Program:

A) The effects of water level fluctuations and reservoir drawdown;

B) The loss of habitat due to erosion, particularly on the north shore of Flathead Lake; and

C) Losses in production and habitat requirements of waterfowl.

This report is a summary of a four-year (1984-1987) study. The results of investigations conducted in 1986 and 1987 are reported in more detail, as appropriate, to complement annual reports from previous years (Casey et al. 1985, 1986). The study was designed to identify the current size and productivity of the goose population, describe habitat conditions and their relationship to water level fluctuations, and to develop potential protection, mitigation and enhancement strategies for this population and its habitats. A similar study was conducted by the Confederated Salish and Kootenai Tribes (CSKT) to evaluate the impact of water level fluctuations due to Kerr Dam on Canada goose populations inhabiting the southern half of Flathead Lake and the lower Flathead River below Kerr Dam. Coordination of the objectives, methodologies, and data analysis in these two studies provided a data base which facilitated both impact assessment and mitigation for this species throughout that portion of the Flathead Drainage which is influenced by Hungry Horse and Kerr dams. Both projects were also coordinated with the objectives of the Flathead Valley Canada Goose Committee (a multiagency working group). established in 1975 to promote effective Canada goose management in the Flathead Valley.

Hungry Horse Dam is owned and operated by the U.S. Bureau of Reclamation. The dam, located on the South Fork of the Flathead River, was completed in 1953, and is operated primarily for hydroelectric energy production and flood control. Operation of Hungry Horse Dam is determined in concert with the complex network of hydroelectric systems, power consumption needs, and flood control requirements throughout the Pacific Northwest. Operation of Hungry Horse has altered natural flow regimes in the South Fork and in the main stem Flathead River. The effects of the altered discharges on the main stem are moderated by natural flows from the unregulated North and Middle forks.

Kerr Dam, located 7 km downstream of the natural outlet of Flathead Lake, was completed in 1938. The dam is operated by the Montana Power Company (MPC) under a lease with the CSKT primarily for hydroelectric energy production and flood control. Under current water regimes, the Kerr facility controls water levels of Flathead Lake between elevations 2,883 ft and 2,893 ft with maximum lake elevation reached in July and maintained into September, and minimum lake elevation occurring in March and April.

The earliest studies of the Flathead Valley goose population were conducted by Barraclough (1954, also Geis 1956) who studied nesting and brood-rearing throughout Flathead Lake. She documented 160 goslings using the north shore of the lake in 1953, including some which had hatched at Goose and Douglas islands, 13 km to the south. She speculated that broods hatched from nests along the river north of the lake and from islands at the south end of the lake also may have been reared along the north shore. As early as 1954, there was a concern that the broad expanses of mudflats, which resulted from low lake elevations during the brood-rearing period, might expose goslings to an increased risk of predation (Barraclough 1954).

Craighead and Stockstad (1964) estimated an average spring population of 800 geese and 201 nests in the Flathead Valley from 1953 through 1960. Their research focused on Flathead Lake, two national waterfowl refuges to the south (Ninepipe and Pablo), and the lower Flathead River, an area roughly coinciding with that studied in recent years by CSKT biologists (Gregory et al. 1984, Makey et al. 1985, Matthews et al. 1986). Craighead and Stockstad (1964) documented decreases in the Flathead Valley goose population during the course of their study, but attributed them to excessive hunting pressure rather than to habitat characteristics or hydroelectric operations.

Since the time of Craighead's studies in the 1950's, surveys of geese in the Flathead Valley system have been primarily limited to annual breeding pair counts, brood counts and periodic fall surveys. The Montana Department of Fish and Game (now MDFWP) conducted these surveys until 1974, and the U.S. Fish and Wildlife Service (USFWS) has been conducting annual trend counts (aerial surveys) in the Flathead Valley since 1975. Breeding pair counts, brood counts, and fall migration surveys have all documented extensive use of the federally-administered WPA located on the northern shore of Flathead Lake. Data from these surveys have been used in conjunction with other regional data by the Flathead Valley Canada Goose Committee, to monitor trends and develop management goals for Canada geese in the Flathead Valley (Table 1). During 1983, the committee established population goals for certain portions of the Flathead Valley which were meant to serve as management decision points (Childress et al. 1983). These areas included Flathead Lake and the river below the lake, as well as certain off-river refuges and WPA's (e.g., Ninepipe Reservoir), but did not include the river above the lake. The population goal of 594 nesting pairs still stands as a decision point, now expressed as 594 nests (Ballet al.1985). The number of nests in these trend areas totaled 537 in 1986.

More recently, the committee developed revised population goals, meant to represent biologically and politically feasible increases in nesting effort (unpubl. data, National Bison Range Files). In areas where conflicts with crops or livestock were anticipated, no increases were recommended (e.g., south Flathead Lake), but for most areas, including our study area (Table 1), the committee noted that populations could be increased twofold or more with intensive management.

Ball (1981, 1983) documented Canada goose nesting populations and success in the Flathead Valley during 1980, 1981, and 1982. Recent nesting populations for the entire Flathead system compared favorably to those of the 1950's, (Geis 1956, Craighead and Stockstad 1961, 1964). although decreases in nest numbers occurred on the lower Flathead River and the northern shore of Flathead Lake (Ball 1983). Ball suggested that goose productivity was limited by the lack of suitable brood habitat along most of the lake shoreline and by a shortage of secure nesting sites along the lower Flathead River. Particular concerns related to the effects of water level fluctuations included habitat losses due to erosion, flooding of nest sites, and dewatering of river channels which exposes island nest sites to predation (Ball 1983). Existing data were not detailed enough to identify specific impacts due to hydroelectric development. No data were available from the river stretch upstream of Kalispell; and no studies had been conducted to document nesting and brood-rearing effort along the main stem north of the Lake.

Extensive erosion of the islands at the mouth of the Flathead River was documented by Moore et al. (1982). The acreages of particular habitat types lost to erosion in the delta islands and elsewhere along the north shore were not documented. The effects of island flooding and channel dewatering were documented along the Flathead River below Kerr Dam (Gregory et al. 1984), but had not been assessed for nesting areas along the main stem above Flathead Lake.

Table 1. Population goals for Canada geese in selected areas of the Flathead Valley, Montana, as developed by the Flathead Valley Goose Committee.[a]

	Annual Nestinp Effort (Number of Nests)	
Population Segment (Area)	Current	Management Goal[b]
Lower Flathead River (Kerr Dam - Clark Fork)	70	170
Upper Flathead River (Columbia Falls - Kalispell)	8	30
Upper Flathead River (Kalispell - Flathead Lake)	80	12s
North Shore Flathead Lake (North of Woods, Deep bays)	45	120
South Flathead Lake (Islands)	165	165
Upper Flathead Valley (Off-river sloughs/potholes)	30	60

a/ Developed July 8, 1986.

b/ These were chosen as reasonable biological objectives. The committee selected a lower population goal of 594 nests in selected areas as a decision point for management direction.

OBJECTIVES

The objectives of this study were to document the size, distribution and productivity of the Canada goose population in the northern Flathead Valley, and how they are (and have been) influenced by water fluctuations due to hydroelectric operations at Hungry Horse and Kerr dams. The ultimate goal of the study was to develop mitigation measures for such effects which will be consistent with management goals for the species and with other mitigation procedures developed for the fish and wildlife resources of the Flathead Valley.

Specific objectives of this study were as follows:

A. Nesting Studies

1. Identify effects of water level fluctuations on goose nesting success and nesting habitat, particularly at the Flathead Lake WPA and on main stem river islands.

   a. Describe the distribution (location of nests) and size (pairs, nests) of the breeding population;

   b. Describe habitat parameters at nest sites;

   c. Determine the relative numbers of different nest types (island ground, marsh, stump, structure, natural snag, tree nest):

   d. Determine hatching success (nest fate) for nest type, and their annual variation.

2. Formulate recommendations to protect and enhance Canada goose nesting habitat and nest success.

   a. Identify "secure" and "high risk" nest types and nesting areas;

   b. Describe the use and management potential of natural nest sites and artificial structures.

B. Brood Studies

1. Identify effects of water level fluctuation on gosling survival and brood-rearing habitat.

   a. Document the production, dispersal, and (if possible) survival of goslings:

   b. Describe the location, habitat, and land-use characteristics of brood-rearing areas;

c. Describe habitat selection by broods, particularly in relation to fluctuating water levels.

2. Formulate recommendations to protect and enhance Canada goose brood-rearing habitat.

   a. Identify shoreline areas which have potential as brooding habitat;

   b. Document location of existing brood-rearing areas in relation to fluctuating water levels.

C. Non-breeding Season Studies

1. Identify seasonal trends in distribution and numbers.

2. Identify seasonal trends in habitat use.

3. Describe post-fledging dispersal of local breeders.

D. Habitat Studies

1. Document characteristics of currently utilized habitats as noted for nesting and brood studies.

2. Develop an estimate of past habitat losses along the north shore of Flathead Lake.

3. Document ongoing habitat losses in the Flathead River delta area.

4. Document habitat losses along the Flathead River above the lake attributable to the operation of Kerr Dam.

E. Other Wildlife Species

1. Identify interspecific relationships which influence goose productivity, particularly competition for elevated nest sites, and predation.

2. Identify effects of water level fluctuations on other species, i.e., bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), and particularly other waterfowl, as possible within the scope of surveys conducted to meet objectives outlined for geese.

STUDY AREA DESCRIPTION

Selection of the study area was based on the influences of Kerr and Hungry Horse dams on those portions of the northern Flathead Valley, Flathead County, Montana, known to be inhabited by breeding Canada geese. The study area included 74 km of the main stem Flathead River from its confluence with the South Fork, approximately 6.5 km east of Columbia Falls, downstream to the mouth of the river, on the north shore of Flathead Lake 1.4 km west of Bigfork (Figure 1). The upper portion of this river section, from the South Fork downstream 38 kmto a point **1.2** km southeast of Kalispell, is characterized by gravelly substrates, many islands and gravel bars, and numerous side channels. Islands and riparian bench areas are primarily dominated by deciduous (Populus trichocarpa) or mixed (Populus trichocarpa/Picea spp.) forests, while the dominant land-uses in the adjacent valley are agriculture and suburban development. The most extensively braided area is located near the mouth of the Stillwater River, immediately southeast of Kalispell. Here the river makes an abrupt transition to a single, wide meandering channel of low gradient, with fine sediment substrates and essentially no islands, for the remaining 36 km downstream to Flathead Lake. The characteristics of this lower river reach are accentuated by seasonal water level fluctuations due to the operation of Kerr Dam. Extensive stands of riparian forest occur along some portions of this reach, but in many places they are absent or limited to a very narrow strip immediately adjacent to the river. Land use in the surrounding floodplain is heavily dominated by agriculture, primarily wheat and hay fields.

The study area also included that portion of Flathead Lake north of Deep Bay on the west shore and Woods Bay on the east shore (Figure 1). This southern boundary of the study area was selected to approximate the northern boundary of the area studied by Matthews et al. (1986). Most of the north shore of the lake is designated as the Flathead Lake WPA, and is administered by the USFWS. The north shore is primarily floodplain dominated by flat topography, and is characterized primarily by dense herbaceous vegetation, varying from emergent stands of Typha latifolia Butomus umbellatus and Scirpus spp. to mixed grass/forb cover types (USFWS 1981). Those portions of the east and west shores within the study area, in contrast, are generally steep rocky topography dominated by coniferous forest, with profuse residential and recreational development characterizing the immediate shoreline areas. Unlike the southern portion of Flathead Lake (Matthews et al. 1984), the north end contains very few islands. These are limited to a few small rocky islands near Somers and one island which represents the remnant of the river delta in the WPA.

Though the study was limited primarily to the river and lake areas described, other areas outside the immediate river channel were included. Primary among these were several large oxbows adjacent to the river: Half Moon, Egan, Church and Fennon sloughs

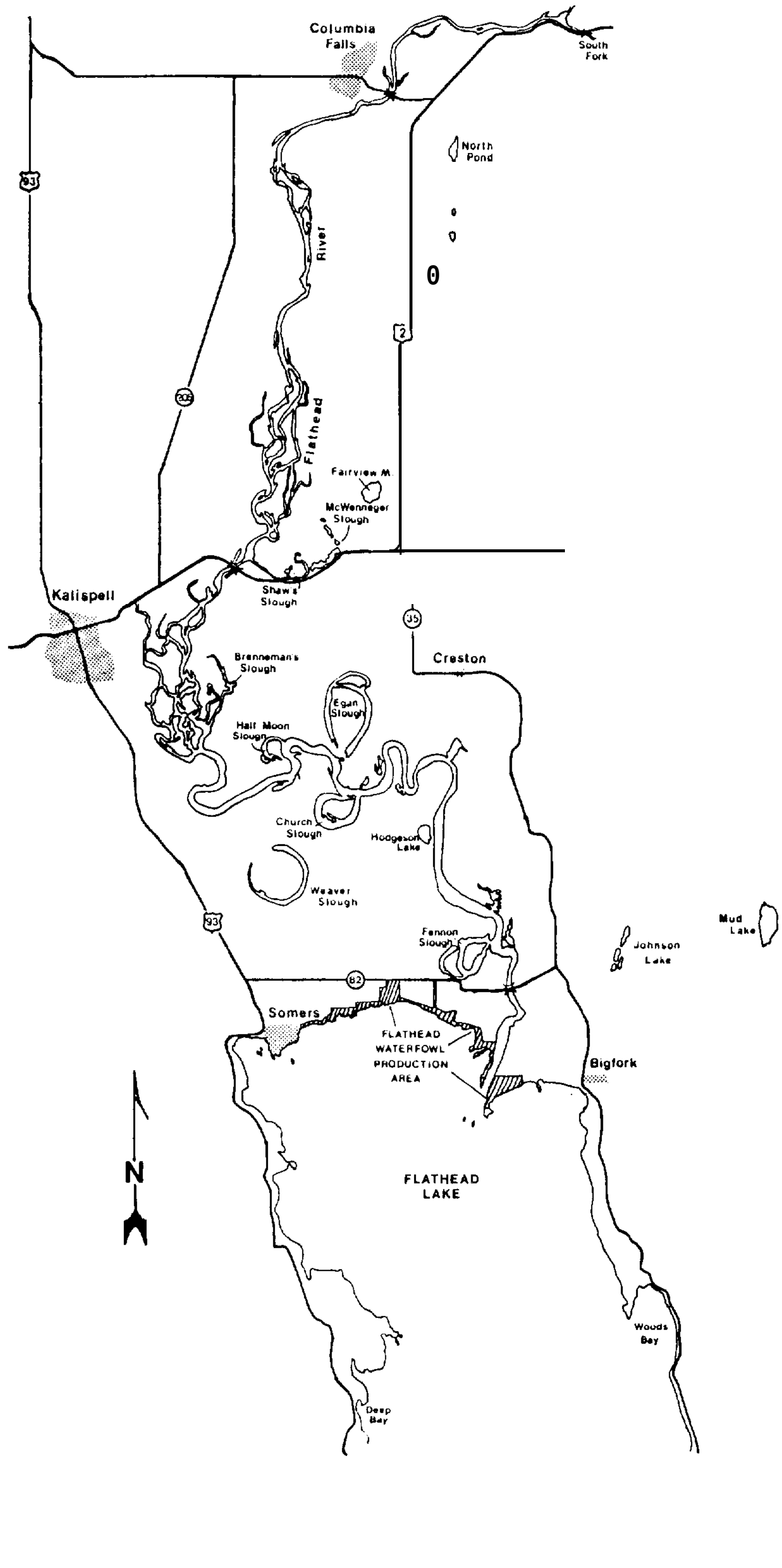


Figure 1. Study area for Canada goose project (BPA Contract 83-498), northern Flathead Valley, Montana.

(Figure 1). These areas were included because their water levels are strongly influenced by Kerr Dam (except Egan); in addition, each received use by geese throughout the breeding season. Similarly, Ashley Creek, Weaver Slough, McWenneger Slough, and Fairview Marsh were included in the study area because of their use by geese and close proximity to the river.

Other areas peripheral to the study area were surveyed occasionally during certain phases of the study, particularly aerial surveys and radiolocation attempts. These included a series of ponds southeast of Columbia Falls along the base of the Swan Mountains, and Johnson and Mud lakes, northeast of Bigfork (Figure 1). Potholes and remnant sloughs between Kalispell and the lake (Lower Valley) and in an area northwest of Kaispell (West Valley) were also surveyed periodically. Swan Lake National Wildlife Refuge, 24 km southeast of the study area, and Batavia and Smith Lake WPA's, 13 km to the west, were surveyed occasionally to document the distribution of local birds and attempt radiolocation of marked birds.

The northern Flathead Valley is characterized by relatively short, warm summers and long, cold winters. The annual mean temperature at Kalispell is 6°C; monthly means vary from -6°C in January to 20°C in July (Gaufin et al. 1976). Annual percipitation at Kalispell averages 38.5 cm; precipitation is greatest during winter (November through January, 11 cm) and spring (May and June, 9 cm), with March, April and August being the driest months. Flathead Lake influences local weather patterns, particularly along the east shore. Bigfork has warmer annual temperatures (8°C) than Kalispell, is cooler in summer and warmer in winter, and has greater annual precipitation (55.7 cm). Two of the four years of this study (1985, 1987) were characterized by warmer and somewhat drier spring weather than normal at Kalispell.

The landscape of the Flathead Basin reflects a history of glaciation. Flathead Lake, the largest natural freshwater lake in the western United States at 125,741 acres (50,498 ha), is a remnant of the enormous glacial Lake Missoula, which was formed by the last of four major glacial advances approximately 25,000 years ago (Zackheim 1983). Soils in the study area are primarily of glacial and alluvial origin.

WATER LEVEL REGIMES

Construction and operation of Hungry Horse Dam as a power peaking facility has had a pronounced effect on water levels in the main stem downstream, except during those times of the year when runoff from the unregulated North and Middle forks overrides these effects (Fraley and McMullin 1983) (Figure 2). Since 1982, a year-round minimum flow restriction of 3,500 cubic feet per second (cfs) has been in effect to protect and enhance salmon spawning in the main stem. Since that time, abnormally low flows probably no

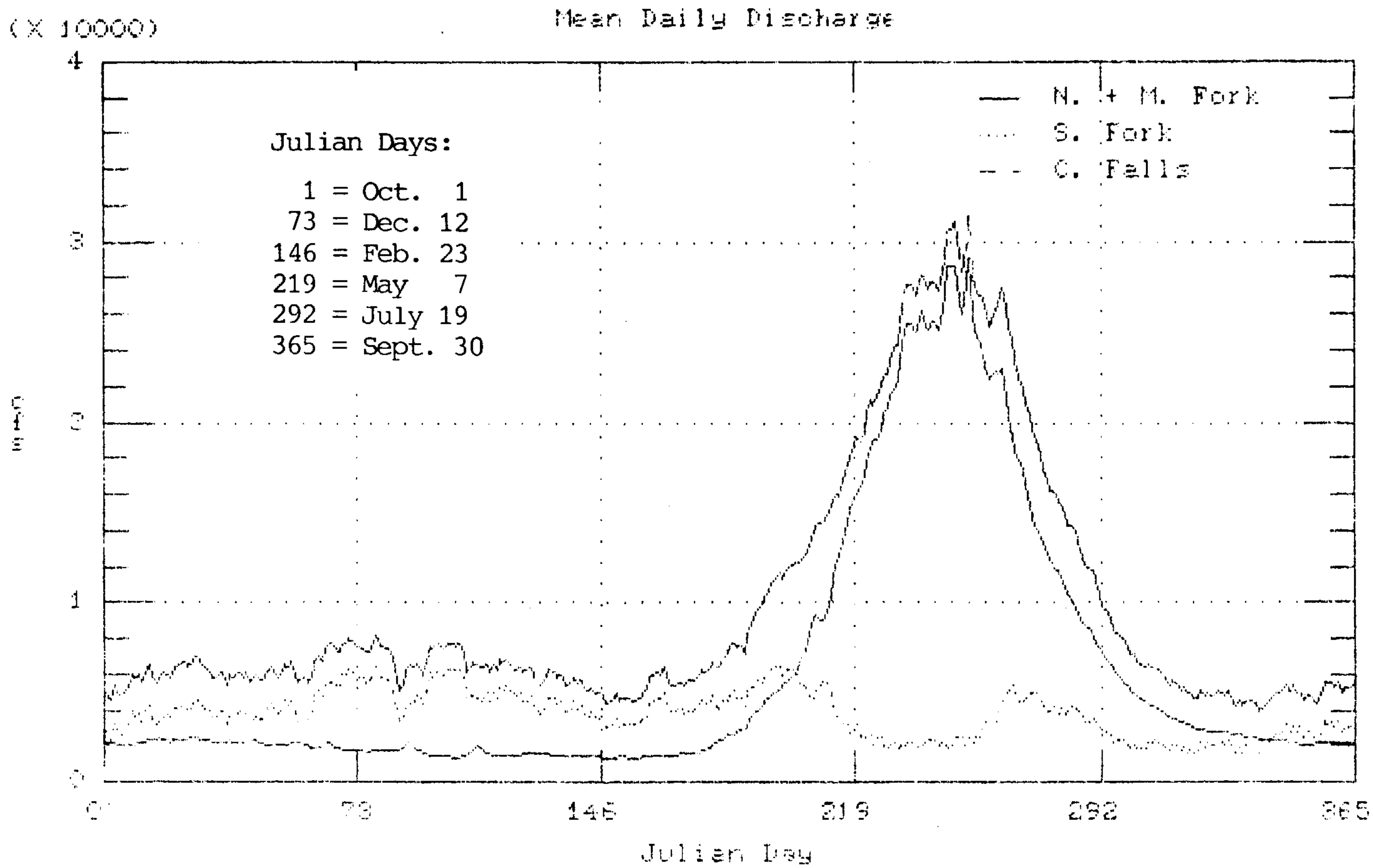


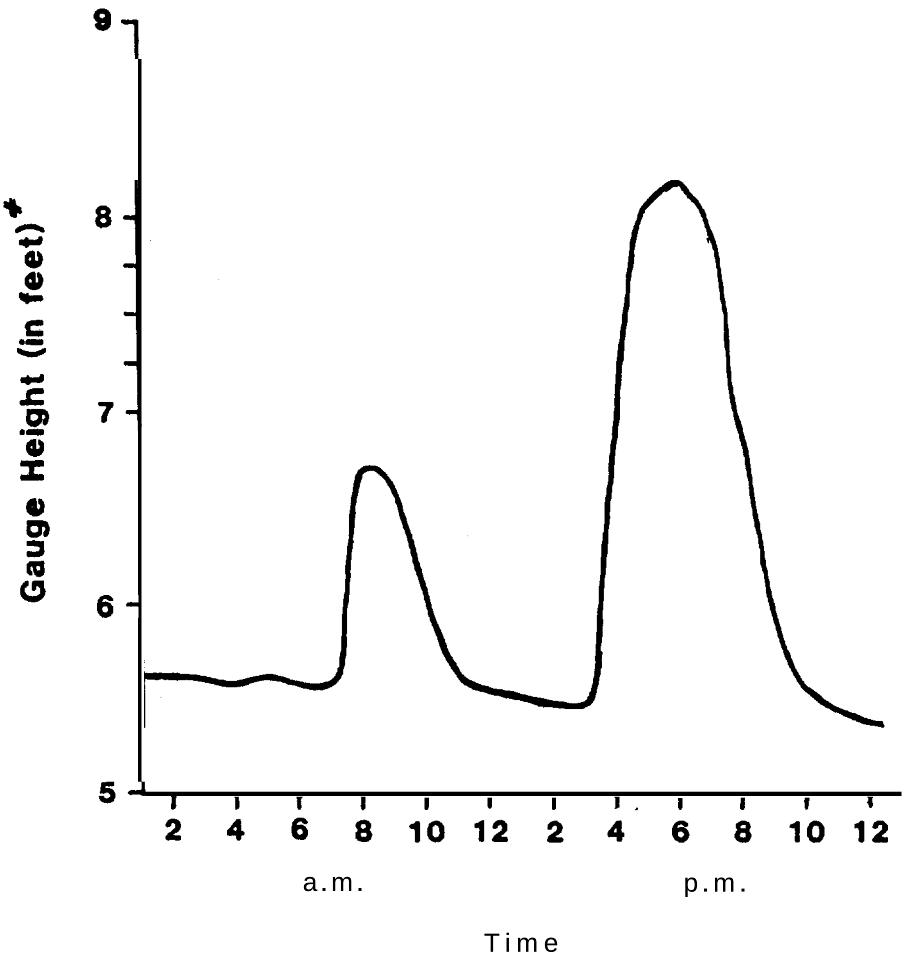
Figure 2. Mean daily discharge, South Fork, combined North and Middle forks, and main stem Flathead River at Columbia Falls, 1955-1986.

longer occur during the goose breeding season. Peaking operations at Hungry Horse can cause abnormally high flows early in the nesting period, when river levels can fluctuate 1 m or more daily at Columbia Falls (Figure 3).

Daily maximum flow data for both the main stem and the South Fork for March through June, 1984-1987 are presented in Appendix A. In contrast to 1984 and 1986, when short-term (three to four day) increases in flow and great daily fluctuations occurred on the main stem (Casey et al. 1985), 1985 and 1987 were characterized by fewer flow peaks of longer duration and smaller daily fluctuations (Figure 4). This pattern can be attributed to high, early runoff and infrequent, generally small releases from Hungry Horse Dam during these particular spring periods, though a few of these flow peaks did include releases from the dam (Figure 4).

Kerr Dam altered the annual pattern of fluctuations in the level of Flathead Lake, by maintaining the lake at peak spring runoff levels throughout most of the year (Figure 5). Subsequent habitat losses have been most severe in the delta area at the mouth of the river (Figure 6), where continued erosion due to wave action had reduced the delta to two small remnant islands prior to our study (Moore et al. 1982). The annual pattern of drawdown and refill for Flathead Lake differed somewhat from year to year during the course of our study (Figure 7).

Wave action (Moore et al. 1982), freezing and desiccation as water levels recede and advance have precluded establishment of emergent aquatic vegetation along much of the north shore, although the acreage of cattails (Typha latifolia) and the exotic Butomus umbellatus have increased in some areas over the past few decades (Hauer et al., in prep.). Expansive mudflats separate upland vegetated areas from open water when the lake is low. During all four years of our study, minimum pool corresponded almost precisely with the nesting and early brood-rearing period for geese (late March through May). Gauge heights (lake elevations) for March through June, 1984-1987, are included in Appendix B.



#Range corresponds to 9110 – 19025 cfs

Figure 3. Main stem Flathead River flow regime for April 26, 1984, as influenced by Hungry Horse Dam and recorded at Columbia Falls, Montana.

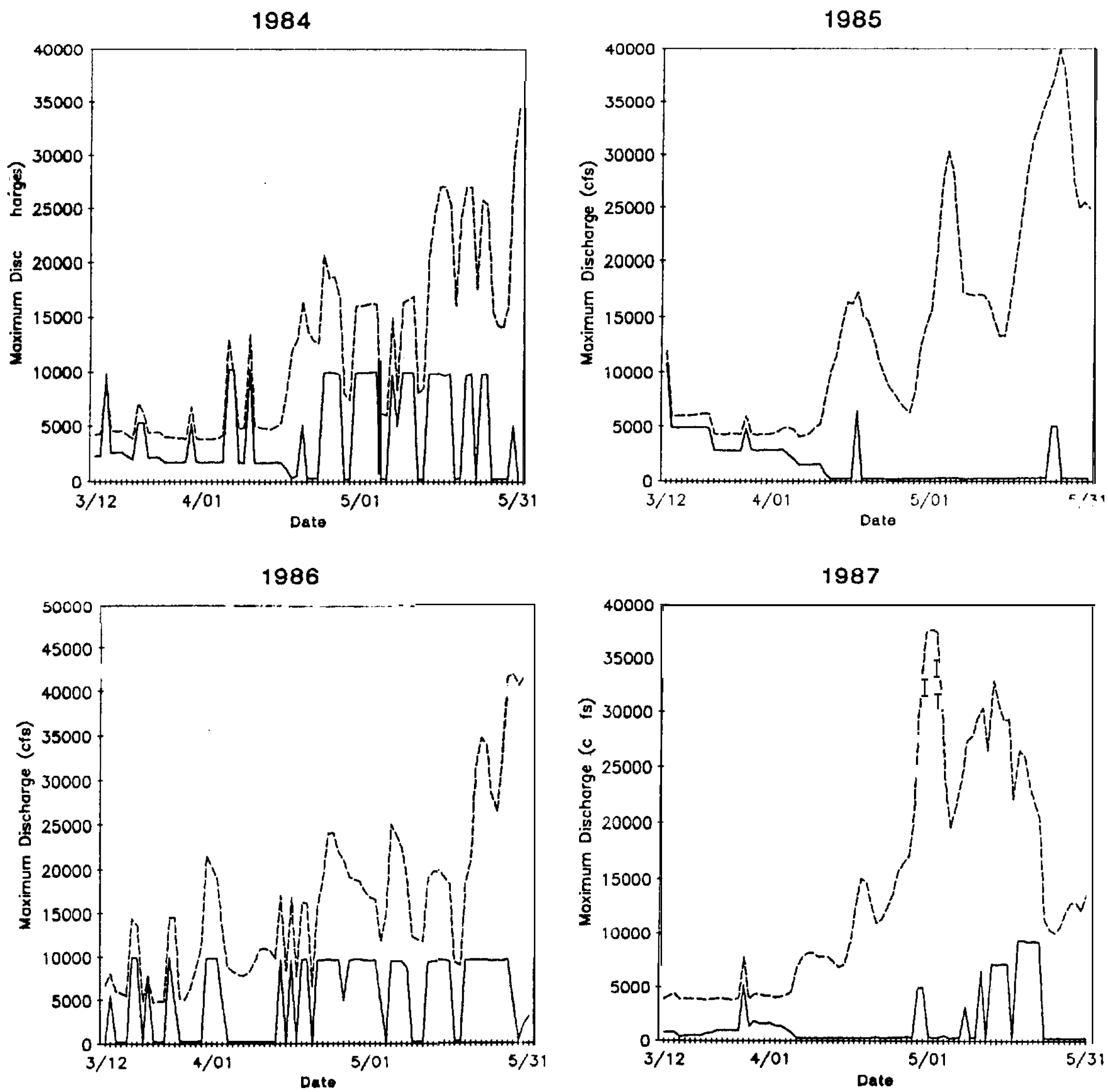


Figure 4. Daily maximum discharge, South Fork and main stem Flathead River at Columbia Falls, March 12 - May 31, 1984-1987.

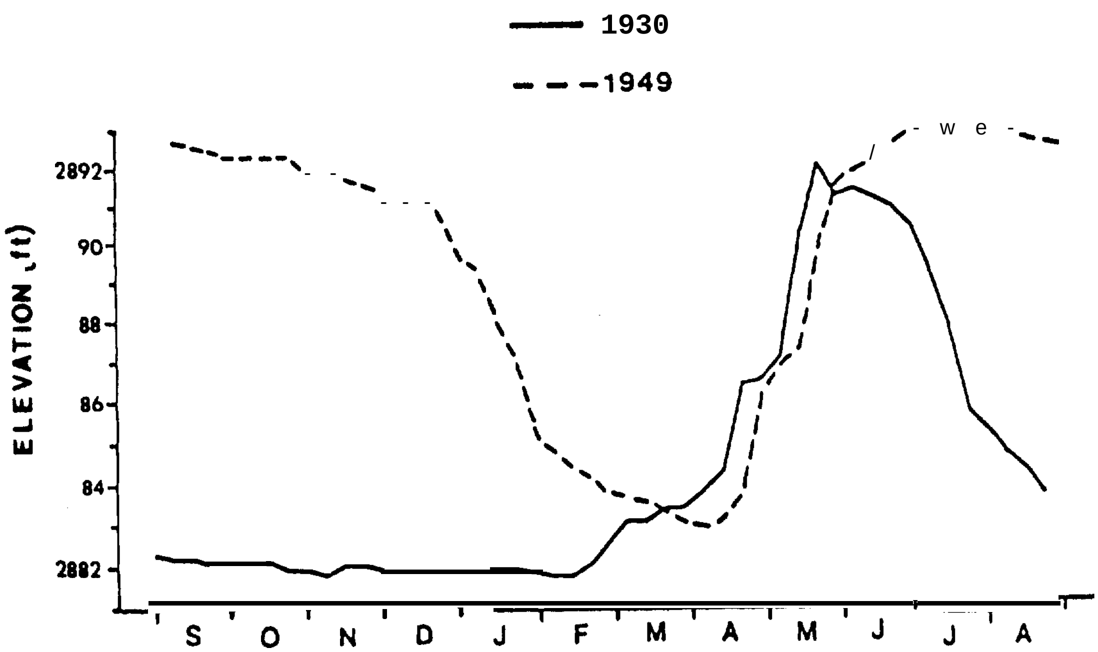


Figure 5. **Annual water level fluctuations of Flathead Lake before and after the construction and operation of Kerr Dam.**

FLATHEAD RIVER DELTA 1937 – 1987

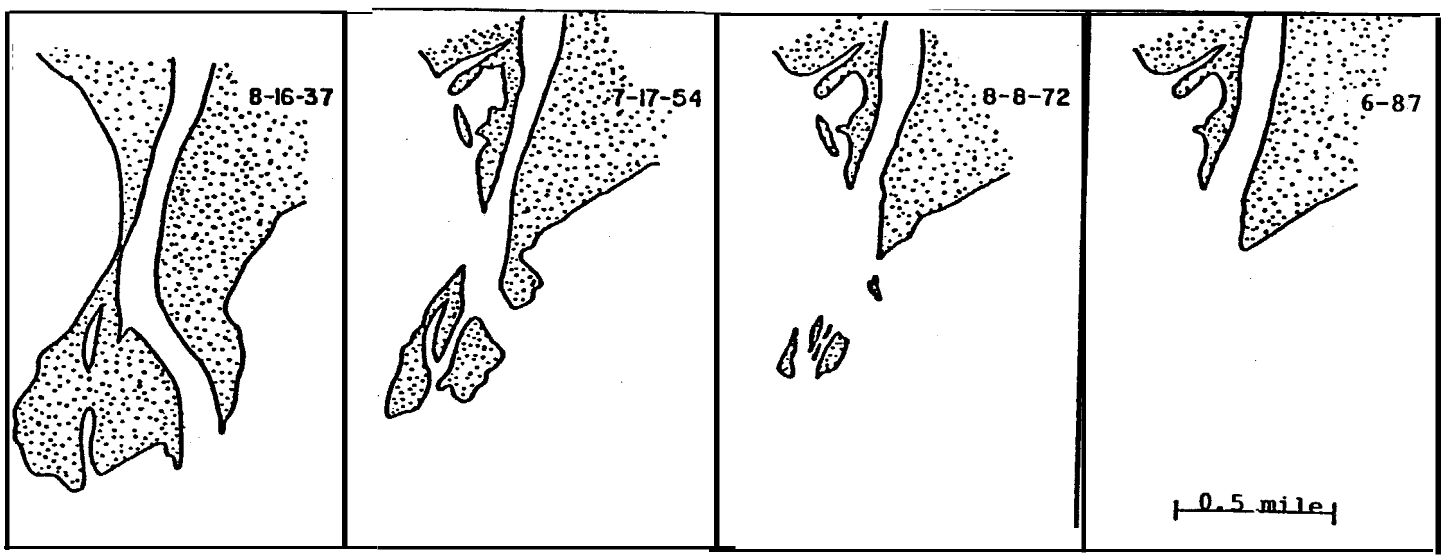


Figure 6. Changes in the Flathead River delta, 1937-1987, north shore Flathead Lake, (after Moore, et al. 1982).

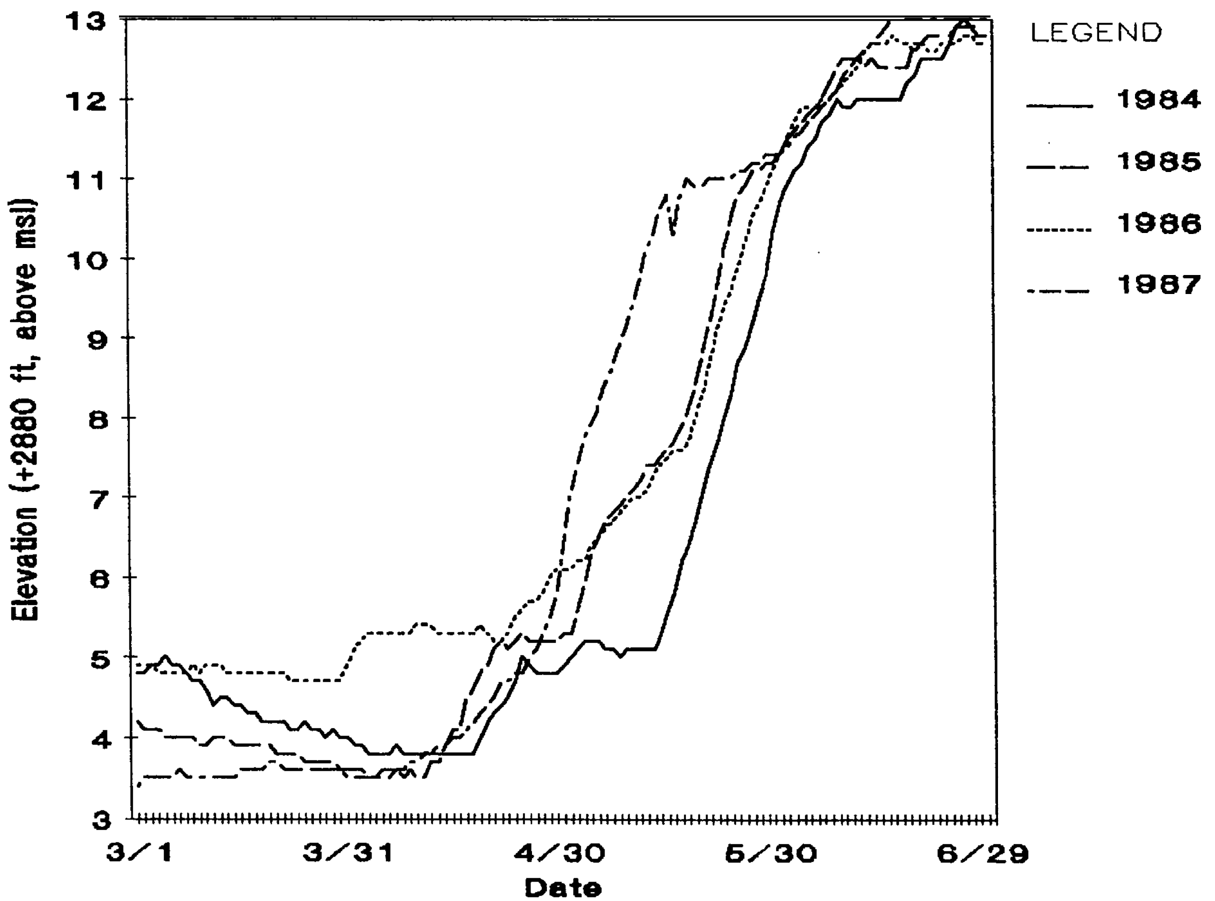


Figure 7. Flathead Lake Elevation as influenced by Kerr Dam, March 1 - June 30, 1984-1987.

METHODS

POPULATION SURVEYS

Aerial surveys were conducted on a year-round basis throughout the study. Surveys were typically conducted once every two weeks except during the breeding season, when they were done weekly. Additional boat and ground surveys of the number and distribution of geese were conducted during summer (post-breeding season), autumn and early winter. The number, location, and activity of all geese observed during these surveys was recorded and mapped; when possible the number of adults and goslings in each flock was recorded. Opportunistic observations of geese during habitat fieldwork during these months were also recorded. These surveys documented the seasonal trends in goose numbers prior to and during the hunting season, seasonal importance of habitats within the study area, and the dispersal of local breeders. These data were useful for describing the seasonal importance of fluctuating water areas as loafing and feeding sites.

NESTING STUDIES

Field studies during each breeding season were initiated during February, when the first inventories of tree nest sites were conducted. Pair counts and nest searches were continued into May to document the number, location and fate of goose nests.

Pair Surveys

Surveys of territorial pairs were conducted throughout the study area on a weekly basis from early March through early May, using a combination of aerial, boat, and ground surveys. Aerial surveys were selected as the most efficient way to systematically survey the entire study area. Eight aerial surveys were conducted during 1986 and five during 1987 using a Cessna 172 or a Piper Supercruiser airplane with pilot and one or two observers. Most surveys were conducted between the hours of 0815 and 1115. Other regional researchers have found no significant difference between morning and afternoon surveys, though afternoon counts are more variable (Mackey et al. 1985).

In addition to the aerial surveys, periodic boat surveys of the entire river portion of the study area were conducted using a 75-hp outboard jet boat. Surveys were run at full throttle, goose locations were carefully noted, and alternate channels were run during round-trip surveys to decrease the likelihood of duplicate observations.

During each survey, the time, location, number of geese, and behavior were recorded. Singles, pairs, nests and flocks were recorded using methods similar to Hanson and Eberhardt (1971) and Allen et al. (1978). Pairs of geese were counted as indicated territorial pairs if they were at least 10 m from any other geese when observed. Lone geese were assumed to be males of nesting pairs, and therefore also were counted as an indicated territorial pair. The location of each indicated pair was mapped. Selection of areas to be searched for nests was based on these locations. The location and status of occupied nests were recorded for each nest observed during the pair surveys, and females on nests were counted as territorial pairs if no lone (presumed male) goose was seen within 200 m.

Nest Searches

Nest search efforts for the 1986 and 1987 breeding seasons (Appendix C) were similar to those conducted in 1985 (Casey et al. 1986). The 1986 effort included: an inventory of all elevated nests in the study area; ground searches of the remaining delta area in Flathead WPA, dredged islands in the western portion of the WPA, six islands in Somers Bay at the north end of the lake, and 53 selected river islands; and ground and boat searches for marsh nests in selected WPA off-river wetlands and sloughs (Brosten's Pond, Egan Slough, McWenneger Slough). The 1987 nest search efforts were very similar, but included 65 river islands.

Results of our 1984 studies indicated that elevated nest sites are particularly important to the northern segment of the Flathead Valley goose population. Nest search efforts were initiated during late February of each subsequent year, with an inventory of all elevated nest sites within the study area which might be suitable to geese. These included vacant nests built by ospreys, bald eagles, red-tailed hawks (_Buteo jamaicensis_) and great blue herons (_Ardea herodias_) as well as artificial nest structures. The location of each nest was mapped, and each was given a code number. This inventory was continually updated throughout the course of the study as more nest sites were found. The status of each nest (species in occupancy, number and behavior of birds on or near the nest, nest condition) was also updated throughout each breeding season, based primarily upon the results of the aerial pair surveys.

Annual helicopter flights to document occupancy and clutch size of elevated nests were initiated in 1985. Helicopter surveys were conducted April 24, 1986, and April 24, 1987. These flights were most useful for locating goose nests in the broken, hollow tops of natural snags, which were easily missed during airplane and ground surveys.

Throughout and immediately after the nesting season (mid April to early June) ground searches for nests were conducted throughout the study area. Previous studies have shown that most ground nesting in the Flathead Valley occurs on islands (Geis 1956, Ball 1983, Gregory et al. 1984, Casey et al. 1985). Islands to be searched were selected based on the following criteria:

a. The presence of potential breeding pairs, as indicated by pair survey data;

b. Known nesting in previous years;

c. The presence of particular representative habitats and island sizes.

Criterion (c) was used in order to gather data representative of a variety of island types within the study area, because a complete census of all river islands each year was not feasible. Nest search efforts were concentrated on smaller islands dominated by herbaceous or shrubby habitat, though some larger wooded islands were also searched.

The river island areas searched for nests were primarily north of Kalispell and in the heavily braided river section immediately southeast of Kalispell (Figure 1). Larger islands were searched using volunteer help from the University of Montana. Teams of three to seven people spaced approximately 10 m apart completely searched each island, except on the largest islands, where only the outermost 50 m was searched. Research has shown that the majority of island nests (59 to 84 percent) are within 10 m of the shoreline (Mackey et al. 1985, Casey et al. 1985). Smaller islands could be searched completely by one or two observers. Nests were usually found by spotting the female on the nest or by observing bits of down on vegetation near the nest.

The remnant delta area in the Flathead WPA was searched completely for nests on April 25, 1986, and April 29, 1987, as it had been in 1985. These mudflats had not been searched for stump nests by previous investigators (J. Ball, Montana Cooperative Wildl. Research Unit, pers. commun.).

Islands in dredged ponds in the extensive cattail stands along the north shore (central portion of the WPA) were searched for nests each year. These sites varied from small natural hummocks to larger islands dredged by the USFWS in 1978 (USFWS 1981).

The location, number of eggs, stage of egg development (or nest fate), nest materials, general cover type and adjacent habitats, and distance to water were recorded for each nest. We attempted to visit all nests at least twice, before and after hatching, though many nests were not discovered until after hatching. In order to minimize nest disturbance, decrease heat loss by the eggs, and prevent predation, a minimum amount of time was spent at each nest, and the eggs were covered with down upon leaving. Egg stage was determined by floating, using methods similar to Westerskov (1950) and modified based on an experiment we conducted to verify this technique for Canada geese (see below). Nest fate was determined from eggshell fragments (Rearden 1951). Nest success was calculated as the percent of total nests of known fate in which at least one egg hatched (Geis 1956). Hatching success (percent of eggs in a clutch which hatched) was noted when possible.

Nest Chronology

The timing of nest initiation and hatching, particularly for ground nests on river islands, had to be described in order to assess the potential effects of water level fluctuations. Nest chronology was investigated at most ground and stump nests, and a few elevated nests.

Egg Flotation Experiment. The egg flotation method was applied to a five-egg clutch laid by a captive Canada goose pair from wild stock. Eggs were marked (numbered) on the day they were laid. After the fourth egg was laid, each egg was floated daily until the entire clutch was pipped. Eggs were floated in a large coffee can, using water from a small pool provided to the captive birds. On eachvisit to the nest, the air temperature and water temperature were noted, and the egg stage was recorded for each egg as a function of its position in the water column, using codes based on those identified by Westerskov (1950). Additional comments on the status of the nest, incubating bird, attending gander, or individual eggs were noted as appropriate.

Dates of initiation of egg-laying, initiation of incubation and hatching were estimated using egg stage data or known hatching dates. These calculations were based on the assumptions of a 28-day incubation period, preceded by a seven-day egg-laying period (Hanson and Eberhardt 1971, Bellrose 1976). When using egg stage data, we assumed that the egg stage for natural clutches closely approximated our experimental data. These data differed substantially from the assumption of equal length stages we had used in previous years (Casey et al. 1985, 1986). so the chronology of nests for those years was recalculated using the experimental data. We assumed one day pipping, one day hatching, and one day brooding in the nest. Because of the assumptions inherent in the back-dating method, and imprecision of the egg-floating technique (Westerskov 1950) for determining egg stage, we typically determined a two- to ten-day period during which a nest was initiated or hatched, rather than identifying such dates as "on or before" a give date. For graphic representation of nest chronology throughout the study area, bar charts were developed by combining these estimated periods for each nest. Each bar, therefore, corresponded to the number of nests which may have been initiated on a given date. These graphs were, therefore, essentially probability distributions for peak initiation and hatching dates within the study area.

Data from the nest searches were used to develop a minimum knovntotalof active nests for each year. An assessment of the accuracy of this total was based on a comparison of nest count data and with the indicated pairs data, using pair/nest ratios calculated by other local and regional studies (Hanson and Eberhardt 1971, Ball 1981, Gregory et al. 1984), mapped pair locations, and by comparing brood count data to hatching success data.

BROOD STUDIES

Production, distribution, and survival of broods were documented through a combination of aerial, boat, and ground surveys. Surveys of the entire study area were conducted weekly (when possible) during the brood-rearing period (early May through late July). For each brood observation, the time, location, number of adults, number of young, age class of the young (Yocom and Harris 1965), and habitat were recorded. Aerial surveys were selected as the most efficient way to survey the entire study area for broods, and yearly maximum counts from aerial surveys were used as an index to annual production.

We attempted to document survivorship of broods in several ways during the course of the study. During 1985, we analyzed 316 observations of individual broods, by age class (Yocum and Harris 1965), and by date, to see if mean brood size decreased through time. Individual broods were defined as any number of goslings attended by two or fewer adults. In 1986 we attempted to document the survival of individual broods through marking, through the injection of dye (Geis 1956) into advanced-stage eggs in three nests, and direct application of permanent ink to newly hatched goslings in six nests. We also developed an estimate of gosling survivorship by comparing our maximum gosling count to the production estimated by multiplying the number-f nests by the nest success rate, by the average clutch size. We assumed that hatching success was nearly 100 percent.

The locations of important brood-rearing areas were determined through a combination of radiotracking of collared adults with broods, the periodic brood surveys (mapped brood observations), and use of three 6-m observation towers which were constructed within the WPA. The locations of these towers were selected based on preliminary results of the brood surveys, discussions with USFWS personnel, and the distribution of habitats within the WPA. The towers were located in areas which allowed for relatively complete visual coverage of the WPA and adjacent habitats.

Brood Activity Budget Surveys

In order to document behavior, habitat use and habitat selection by broods of various age classes, we utilized activity budget surveys (Altmann 1974) as modified by Matthews et al. (1985). These surveys (N=353) were conducted from late April through mid July, in both 1985 and 1986. They were conducted primarily from the three observation towers at the WPA (N=151, 1985; N=123, 1986), although broods were surveyed at other upriver brood-rearing areas when possible (N=26 in 1985; N=53 in 1986). Whenever possible, activity budget surveys were performed on broods with radio-collared adults, because they were easy to locate and maintain as the "focal" brood for the 30-minute survey period. In all other cases where more than one brood was visible, focal broods were selected by setting the 50/80x scope at a compass bearing taken from a random numbers table, and scanning in a clockwise direction until a brood came into the field of view.

If several broods were together in a gang brood, one brood was selected for sampling. The activities and locations of one brood were monitored throughout the entire sampling period when possible. However, if the brood left the area or became mixed with other broods, we selected another brood for sampling. Frequently, two or more consecutive surveys were conducted using the same focal brood.

Over 90 percent of the surveys were conducted during the hours 0500-1030, particularly those at the WPA. Broods were most easily observed in early morning because they were active and undisturbed, and optical distortion due to heat waves was minimized.

During each survey, one observation was made each minute within a 30-minute sampling period. For each observation, the activity, habitat (cover) type, and landform of one systematically selected gosling and one adult within the brood was recorded on coded data sheets (Appendix D). Gosling age classes were recorded using the plumage characteristics described by Yocom and Harris (1965).

Those surveys with ten or more "out of sight" records were dropped from the final analysis. Most of the analysis of activity budget survey data was performed by transforming each survey (N=312) into one set of values which represented the percentage of that particular survey which was spent in a particular activity or habitat (cover) type. These percentage values were then used to compare the cover type use and activity of goslings and adults at various lake levels and between sites. Cover type use by adults and goslings was highly correlated (r=0.99), so only goslings were included in that analysis. Cover type and landform were combined into one set of cover type codes for the final analysis. Raw data (e.g., 30 observations per survey) were used to compare the differences in gosling and adult activity between various cover types.

HABITAT MEASUREMENTS

Nest Site Habitat Measurements

Nest site characteristics were describedusing a variety of measurements of the physical environment andvegetationinthe immediate vicinity of the nests. Descriptions of the physical environment at each nest site included the type of nest (ground, tree, marsh), lateral and vertical distance to existing water level and to the seasonal high water mark (HWM, recorded to nearest 0.1 m), and evidence of disturbance or interspecific interactions. Of particular interest in the latter category was documentation of competition for, displacement, or alternate occupancy of osprey, bald eagle, or great blue heron nests by tree-nesting goose pairs. Seasonal high water mark vas determined through evidence of scouring, vetted soils, or debris deposition.

Physical habitat and vegetation measurements were collected on 155 nest sites during the four field seasons. Nest sites were analyzed by nest type because of major differences in vegetation and physical characteristics. Nest types recognized included ground nests, marsh nests, tree nests, and stump nests.

Which vegetation measurements vere collected in the immediate vicinity of nests depended on the type of nest sampled. However, at all sites, cover type (Appendix E) and landform (Appendix F) were identified. Cover type classifications were based on existing vegetation and reflected the general structure of the habitat.

Ground Nests

Canopy cover at ground nests was estimated using the line intercept method (Canfield 1941), along a 10-m. north-south line with the nest at the mid point. Percent cover by class (graminoid, forb, shrub, tree, bare ground, litter, and log) was calculated by recording coverage to the nearest 0.1 m. Moss was grouped with litter, and water was grouped with bare ground.

Overhead cover was estimated using a densiometer (Lemmon 1956) held at a height of 0.5 m over the nest and at each of the four cardinal directions 5 m from the nest (plot center). Woody stem density was measured at each ground nest site and 5 m from the nest (plot center) in each of the four cardinal directions and all five counts were averaged. All woody stems at a height of 1 dm, were counted within a 1 m^2 circle defined by a plastic hoop.

Ground Nest Site Selection, Nest distribution by cover types and habitat availability were compared in the upper river portion where most of the island ground nests were found. The distribution of nests by cover types was compared to the overall distribution of cover types on islands to test for differences.

The proportions of cover types on islands was calculated from the cover type maps. Using these percentages, the expected frequency of nests was calculated and tested with the Chi-square test. The distribution of nests was compared to the distribution of cover types on the nest islands to test for habitat selection. Nest distribution was also compared to all islands. Only those islands found in the upper river which were 30 acres or less in size were included in the analysis because the largest island used for nesting was 29 acres in size.

To determine whether geese select nesting islands based on their size, we compared islands used for nesting and islands not used for nesting. Selection of islands based on size was also compared using size classes. Significant differences were tested with a t-test.

Marsh Nests

Methods were modified slightly for marsh nests. Percent cover at the nest site was described using the same method as for ground nests; however, the classes were changed to include emergents, aquatic vegetation, forbs, and open water. No densiometer measurements were taken. Vegetation heights and water depth were recorded at marsh nests sampled in 1986. Distances (recorded to nearest 1.0 m) to open water and upland vegetation were measured each year. The diameters of muskrat lodges andvegetation mats supporting the nests were measured.

Stump Nests

Fifteen stumps used for nesting on the Flathead River delta were measured in 1985. The height and circumference of the stump, height, maximum and minimum depth and width of the bowl portion of the stump which contained the nest, height of nest above existing water level, and the aspect and relative amount of decomposition of the top of the stump were recorded. Aspect was defined as the orientation of the lowest point in the rim of the depression containing the nest. The elevations of the nests were calculated using gauge height data and nest height data from each day these nests were measured. This allowed us to calculate the height of the nests relative to full pool, and the date of nest inundation for those stump nests below the full pool elevation.

Six newly-used nest stumps, ten of those measured the previous year, and 172 other flat or concave-topped stumps >35 cm in diameter were measured in 1986. The latter were selected to identify those characteristics of stumps selected by geese, and represented all stumps on the delta which geese could physically use as nest sites. All other stumps were counted and recorded as <35 cm, convex-topped, too eroded, or too hard, and, therefore, totally unsuitable as nest sites. For the 1986 effort, we included indices of friability (softness), amount of stump surface left uneroded, and percent of the rim (if any) which was above back height (20 cm). We remeasured ten stumps which had been measured in 1985, and took wood samples from all 188 stumps for species identification. Stump measurement data were analyzed using a step-wise discriminant function analysis to compare used and unused stumps, and to compare stumps used only one year to those used both years.

All stump nests were permanently marked for future reference. Markers consisted of large metal washers embossed with nest code numbers nailed to the stumps at approximately chest height. Three of the stumps so marked were used as reference photo points to document erosion of the remaining vegetated islands throughout the last three years of the study.

Tree Nests

In addition to the vertical and horizontal distances (recorded to nearest 0.1 m) to the high water mark, specific data on tree nests were collected. Tree nests were classified according to three categories: dead snags, dead-topped live trees, or tree nests built by other species (generally ospreys). The diameter at breast height (dbh) was measured for each tree nest. Tree and nest heights were measured with a clinometer. Most tree nests were permanently marked for future reference, as described for stumps.

Brood-rearing Area Habitat Measurements

Brood-rearing areas which received consistent use, or those areas occupied by large numbers of broods were identified as key brood-rearing areas. Specific plant communities within these key areas were described. If several distinct communities were present, each was sampled. Physical parameters including landform and vertical/lateral distance to the high water mark and the existing water level were described (Gregory et al. 1984). Vegetation characteristics were described using several methods. Herbaceous cover was determined by recording percent coverage (Daubenmire 1959) for each species or species group found in ten circular frames (1 m^2), located in pairs at 5-m intervals along a 25-m transect. Cover by general classes such as graminoid, forb, shrub, and tree were recorded by percent along a 10-m transect. Tree and shrub cover was determined by recording species coverage in 10-m diameter circular plot placed at each end of the 25-m transect. Overstory cover was determined using a densiometer (Lemmon 1956) read at the center of the two circular (10-m diameter) plots. Cover type(s) (Appendix E) were recorded at each site.

COVER TYPE MAPPING

In order to describe brood and nesting habitat available to Canada geese occupying the upper river portion in the study area, a cover type map was drafted. Riparian habitats were mapped on infrared aerial photographs (1978 series; scale 1:2,400) and black and white aerial photographs (1979 series; scale approximately 1:16,000). The map boundary included the riparian zone as defined by either a change in vegetation, a distinct increase in elevation, or the presence of a road. Cover types were definedbased on major differences in vegetation structure and species composition and incorporated habitat and wetland type classifications of Pfister et al. (1977), Pfister and Batchelor (1984), Cowardin et al. (1979), and Mueggler and Stewart (1980) (AppendixE).Because of changes in island morphology in the heavily braided area near Kalispell (Figure 1), it was necessary to augment the infrared photographs with current aerial reconnaissance and oblique photos. Acreages were calculated to the nearest 0.1 acre using an electronic digitizer. All habitat mapping was field-checked. In addition, sites representative of the cover types were measured using the same methods described for sampling the brood-rearing areas.

Habitats available on the river below Kalispell and the north shore Flathead Lake were described based on maps developed as part of another study on erosional processes (Hauer et al. in prep.). Cover types were similar to those used to describe habitat distribution on the upper river (Appendix E).

DETERMINATION OF HABITAT LOSSES

In addition to documenting direct impacts that operation of Kerr and Hungry Horse dams have on the resident goose population, we also documented historic impacts on terrestrial habitat. Habitat losses were determined by comparing pre-dam photos (1937) to current aerial photos similar to methods we have used in other loss estimate documents (Casey etal.1984; Wood and Olsen1984; Yde and Olsen 1984). Habitats lost to inundation and erosion along the north shore of the lake were determined using black and white aerial photos (1937 series, scale 1:22,0000). Cover types of existing vegetation were identified with a stereoscope and mapped. A habitat loss estimate was then developed by overlaying this habitat map with a map of the current shoreline outside the cattail vegetation, which was developed through a separate mapping effort with aerial photos taken June 1, 1985, when the lake was nearly at full pool (2,891.3 ft). Thus habitat cover type and acreages were determined **Afor** an area between the shoreline existing in 1937 and the emergent vegetation present in June 1985.

Pre-dam habitat conditions were further verified by reviewing old photographs and historical documents found in the archives section of the University of Montana library. In addition, long-time residents along the north shore were interviewed. Current data on historical and on-going erosion impacts were reviewed, particularly the research conducted by Moore et al. 1986 and the University of Montana Biological Station (Hauer et al. in prep).

Ongoing losses of habitat in the remnant river delta in the Flathead WPA were quantified in severalways. Use of reference photo points provided a pictorial record of island erosion. Measurements of the dimensions of the two small vegetated island remnants were taken in 1985 and 1986, respectively, in the years shortly before they were lost completely to erosion. All remaining stumps were counted during January 1987 for comparison with our minimum count recorded during May of the previous year, to quantify losses of this particularly important nesting habitat component. These data were used to develop an estimate of the length of time that nesting habitat will still be available in the delta.

Habitat losses occurring on the river below Kalispell and influenced by Kerr Dam were developed from data suppliedby the Biological Station (Hauer et al. in prep.) and from current research on water level impacts to aquatic furbearers (Bissell and Bown in prep.).

TRAPPING/BANDING/RADIOTELEMETRY

Radio-marking of adult geese was an integral part of our field studies. Our objectives were to gather data throughout the nesting and brood-rearing period in order to describe movements between nests and brood-rearing areas, and to describe the habitat use and dispersal of broods. We also hoped to document both local and regional movement patterns during the non-breeding season, particularly the potential interchange between birds in our study area and in the area studied by the CSKT.

One trapping effort was made in 1986, to supplement radios put out in previous years (Casey and Wood 1985, 1986). We trapped during late winter in order to radio-equip adult geese prior to the nesting period. The trap site was along the main stem Flathead River west of Egan Slough, where we had trapped in 1985. The trap site was pre-baited with whole wheat from March 3 through March 10. A single rocket-net was used to capture geese during 11 trap-days between March 18 and April 1. Three geese were equipped with radio-collars and one additional bird was banded, bringing our totals for four years to 80 banded geese, 26 of which were equipped with radio-collars (Appendix G).

Throughout the course of the field studies, attempts were made to locate these 26 radio-marked geese, through the use of a hand held antenna during boat and ground surveys for nests and broods, and use of two wing-mounted antennas during most aerial surveys. Both low-level (<100 m) and higher flights (ca. 300-1,000 m) were conducted. Visual confirmation of the location of marked birds was attempted for each radiolocation, and each was mapped. Coordination with the CSKT study regarding radiolocations was maintained throughout the course of the study. CSKT biologists provided locations for MDFWP radio-collared geese found on the southern half of Flathead Lake and nearby reservoirs.

ANALYSIS OF DATA

Data were entered, stored, and manipulated using a Leading Edge micro-computer, with dBase III+ software (Ashton-Tate 1985). STATGRAPHICS software (Statistical Graphics Corp. 1986) was used to perform most statistical tests (correlation, Students-t, paired-t, Chi-square), with the exception of the discriminant function analysis of stump characteristics, which was performed using SPSS software on the mainframe computer at the University of Montana. Report graphics were primarily generated through the use of CHARTMASTER software (Decision Resources 1986).

Water Level Chronology

Analysis of water levels for the four years of the study and previous years conducted using unpublished data from the U.S. Geologic Survey (USGS) and MPC. Many of these data were available in compiled form from Charles Hall at the University of Montana Yellow Bay Biological Station. An emphasis was placed on the timing of releases for Hungry Horse Dam and their potential effects on downstream nests, and the annual fill schedule for Flathead Lake, particularly as it related to the success of nests on the river delta. Lake elevations were also considered in the analysis of brood-rearing activities on the north shore of the lake.

The role that Hungry Horse Dam plays in the success of river island ground nests was first described by identifying those flows at which such nests flood. Daily maximum flows on the South Fork below the dam and at Columbia Falls on the main stem were identified for the period March 12 - May 31, 1984 - 1987. This allowed us to identify those days during each nesting season when releases from the dam had the potential for causing nest failures, and those days when the dam served more of a flood control function. To further clarify the historic role of the dam as regards downstream nests, we analyzed daily mean flows for both areas, for all years since the dam was closed (1954), concentrating on days with high mean flows (>25,000 cfs).

OTHER WILDLIFE SPECIES

No formal surveys for other species were conducted; however, data descriptive of other wildlife species and their habitats in the study area were collected within the framework of the goose studies. Signs of furbearer presence and habitat use were recorded in field notes taken during ground surveys of pairs, nests, and broods of geese. These records were supplied to MDFWP biologists conducting furbearer studies along the Flathead River under funding from MPC. The elevated nest inventory included collection of data describing the location, occupancy, and nest chronology of ospreys, bald eagles, and great blue herons within the study area. These data were useful for identifying potential interspecific conflicts which influence goose productivity and allowed close coordination with the fieldwork being conducted under an ongoing MPC-funded study of bald eagles and osprey. Incidental observations of a wide variety of other wildlife species, particularly waterfowl and shorebirds, were recorded in field notes throughout the course of the studies.

RESULTS

POPULATION SURVEYS

A total of 100 aerial surveys was conducted between April 21, 1984 and May 26, 1987 (Appendix H). Seasonal peaks in numbers typically occurred in March and again in November (Figure 8). as migrants passed through the area. Mean monthly counts differed little on an annual basis (Figure 8), and distribution within the study area was also consistent on a seasonal basis (Appendix H).

Mean counts for the months December-February ranged from 358 to 640 birds, except for the mild winter of 1986/87, when approximately 1,000 birds overwintered (Figure 8). In early March, a large influxes of migrants occurred which accounted for the annual peak populations immediately prior to the nesting season. During the peak of nest initiation, goose numbers again dropped to about 300 birds, which represented local breeders (e.g., **268** or more in 1986) and a few local residents which did not breed. In May, numbers increased as a large contingent of birds passed through on their way to Canada to molt.

June count data were typically the lowest of the year. This trend was probably explained by the tendency of birds with very young broods to stay near cover, and a potential exodus of failed nesters to molt areas elsewhere. July numbers were slightly higher, particularly later in the month, because goslings are then indistinguishable from, and classified as, adults. This trend continued through August when flocking became more prevalent, and numbers counted increased slightly over July. Goose numbers increased during September (Figure 8), as early migrants arrived. October numbers dropped again, however, in response to hunting pressure as the season opened. Cold fronts in November brought large numbers of migrants, with counts dropping again in December as wetlands began to freeze.

Seasonal Distribution and Habitat Use

Consistent patterns of goose distribution were observed over the four years of the study. In January and February, geese used the lower river (below Kalispell) as their major feeding and resting area, particularly in years when Flathead Lake was frozen (i.e., 1984/85, 1985/86), Lower valley fields were important feeding areas this time of year as well, when snow cover was light. These fields were also heavily used from August through December, and during March, when meltwater and new wheat shoots made them ideal feeding/loafing areas. Throughout the breeding season (March - July), distribution was closely tied to nesting and brood-rearing areas, and geese were fairly widespread within the study area. During the fall, particularly once the hunting

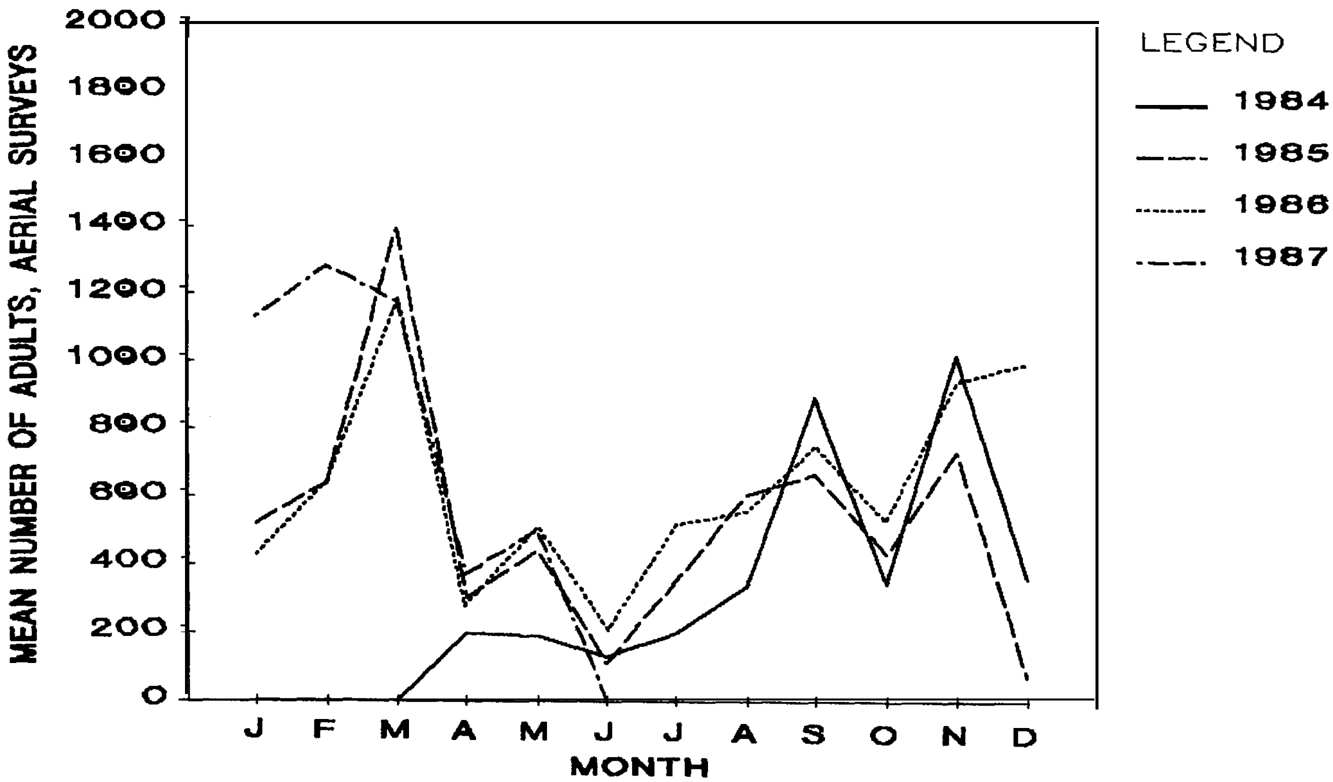


Figure 8. Mean monthly numbers of Canada geese recorded during aerial surveys, northern Flathead Valley, April 1984 - May 1987.

season had begun, the north shore of the lake was heavily used as a security area. The western portion of Flathead WPA, which was closed to hunting, was a very important resting area until the lake froze. Off-river sites where hunting is not allowed (i.e., Mud Lake) also received heavy use during the early portion of the hunting season.

RADIOTELEMETRY

Twenty-six geese equipped with radio-collars during 1985 and 1986 trapping efforts plus two geese radio-collared by CSKT biologists provided data descriptive of habitat use and movements within the study area (Appendix G). During the four years, 560 locations were documented for the 28 radio-collared geese. Most locations were obtained during aerial surveys with additional locations recorded during brood activity budget surveys and general field work.

Status of Radio-equipped Geese

Seven of the 15 geese trapped during the winter of 1985 remained in the study area and provided data on local nesting and brood-rearing (Appendix G). Eight of the geese trapped disappeared from the study area shortly after trapping. If we assume their radios remained functional then these may have been migrant birds. Those birds leaving the area in May could represent non-breeders within the population which participate in a molt migration to secure areas in Canada as documented for other goose populations (Davis et al. 1985). However, three of these birds did not return to the study area and were shot on the Snake River in Idaho during the fall and winter 1985. suggesting these were indeed non-residents.

Eight birds were trapped on the WPA during the molt (late June 1984 and 1985). Three disappeared after trapping and one was shot in Idaho during the fall, 1986. Of the four remaining, one (MY55) nested locally and three were shot locally in the fall and winter of 1985.

A total of eight radio-equipped geese were shot and one goose was presumed dead when the collar vas found in 3 ft of water below Kerr Dam. Four geese were shot on the Snake River in Idaho and four were harvested locally. The 13 geese that remained in the area provided data descriptive of nesting, brood-rearing, and non-breeding seasonal movements.

Nesting and Brood-rearing

Eleven radio-equipped geese remained in the study area for at least one breeding season and provided data descriptive of nesting and brood-rearing which were useful in determining the importance of areas in which seasonal or daily water level fluctuations occur. Tree nests, hollow snag nests, stump nests, and ground nests were used by collared geese. We documented the traditional use of nesting areas and individual nests sites by monitoring these geese. One pair nested in the same site for three years and used the same tree for two consecutive years. In another case, a pair returned to the same stump nest on the delta for two consecutive years.

Data on brood movements and habitat use was provided by the radio-equipped geese. Several important brood-rearing areas on the river and adjacent sloughs were identified and determined to receive traditional use during the four years. These areas were often distant from the nest sites. For three years, one pair nested in the same site at Foy's Bend and took their brood downriver to Ashley Creek, Weaver Slough and Half Moon Slough, 9 km from the nest site.

The importance of the WPA as a brood-rearing area for geese nesting throughout the Flathead Valley was verified by tracking radio-collared geese. Long distances were traveled by broods to reach the north shore. One pair which nested in the braided section near Kalispell brought their brood 37 km downriver to the north shore. Another pair from Egan Slough brought their brood 24 km downriver to the WPA. A radio-equipped goose which nested at the southern end of flathead Lake brought its brood to the north shore.

One radio-equipped pair also provided a unique observation of brood size dynamics. During a time budget survey, we observed the collared pair's brood increase when a lone gosling with another pair was "stolen" and added to the brood. The frequency of such interbrood movements is an important factor in assessing gosling survival, when mean brood size is used as an index to survival.

NESTING STUDIES

Pair Surveys

Geese in the study area were consistently seen in pairs or as singles by early March of each year, and the locations of indicated pairs were consistent by late March, when nest initiation had begun. Analysis of the aerial survey data revealed high variability in early March, and trapping results revealed that many transient pairs are present in the area at that time (several captured pairs left the area). For these reasons, analysis of pair count data was limited to those counts conducted during the last week in March and the first two to three weeks of April, during the peak of nest initiation and early incubation. Data from these particular counts were also the most useful for identifying the specific locations of nesting pairs. Data from one April flight for each of 1986 and 1987 are included for comparison (Tables 2 and 3). Pair totals at the WPA seem to be particularly variable at that time.

The majority of indicated pairs in both 1986 (Table 2) and 1987 (Table 3) were seen on the north shore of the lake and the lower river, as in previous years. The mean pair count data for the years 1985-1987 were calculated for three major areas within the study area in order to calculate pair/nest ratios (Table 4). Previous studies of geese have shown that the number of indicated pairs usually correspond to the number of active nests at a ratio of approximately 1.2 pairs/nest (Hanson and Eberhardt 1971, Ball et al. 1981). Studies elsewhere in the Flathead Valley have noted ratios of 1.2 to 1.4 pairs/nest along the Flathead River below the lake (Mackey et al. 1985). We found much annual variation in pair/nest ratios in our study area (Table 4), even during those years when our nest searches were most intensive and our proficiency at surveys should have been at its peak (1986, 1987). Data from 1984 was not included in this portion of the analysis because the first aerial survey was not conducted until April 21 that year, and our nest search efforts were limited compared to subsequent years. On the north shore of the lake (primarily the WPA), annual pair/nest ratios ranged from 0.94 to 1.42 (2 = 1.14); ratios for the lower river were very similar (range 0.89-1.43, Z = 1.19). On the upper river (above Kalispell), ratios were consistently lower (Table 4).

Boat surveys were shown to yield consistently lower results than aerial surveys in 1985 (Casey et al. 1986), and were, therefore, not included in the pair data analysis for 1986 or 1987. Boat surveys were particularly useful for identifying specific or potential nest locations.

Pair Locations

Mapped pair locations approximated nest locations with a high degree of accuracy in the years when nest searches were most intensive (1985, 1986), with less accuracy during the first year of the study (1984), and surprisingly poor accuracy in 1987, especially for ground nests in the braided river section near Kalispell. In many cases, "excess" pairs were in reality using difficult-to-find nest sites. Therefore, the number of nests found during any particular year is definitely a minimum number. This discrepancy was most pronounced during the first two years of the study. For example, the pair/nest ratio for Flathead WPA in 1984 was 2.6; we were unaware of the extent of stump nesting and did not search the stumps thoroughly. Interestingly, the number of indicated pairs seen in the WPA averaged 39 in 1984. The number of nests found there (including the rest of the north shore) in subsequent years ranged from 30 in 1985, to 42 in 1986, as our understanding of nesting areas and search effort increased. Several areas on the lower river which showed as clusters of pair

Table 2. Canada goose pair count data, aerial surveys, northern Flahtead Valley, 1986.

Date	Flathead Lake WPA[a]			Flathead River: Kalispell-Lake[b]			Flathead River: Col.Falls-Kalispell			Valley Pothole&			McWenneger Slough			TOTALS		
	P	S	IP[d]	P	S	IP	P	S	IP	P	S	IP	P	S	IP	P	S	IP
March 26	38	14	52	39	20	59	12		3	8	3	11	9	2	11	95	41	136
April2	41	14	55	36	25	71	0	2	2	4	3	7	8	6	24	89	60	149
April10	21	25	46	28	27	55	3	2	5	3	7	10	7	6	13	62	67	129
Apirl 15	21	18	29	19	42	61	5	4	9	6	4	10	9	8	17	60	76	136
April 23	7	11	18	45	36	81	-	-	-	-	-	-	-	-	-	(52)	(47)	(99)

a/ Flathead Lake Waterfowl Production Area: also includes all of Flathead Lake north of Deep Bay on the west and Woods Bay on the east.
b/ Also includes the following off-river or adjacent sloughs: Church, Egan, Fennon, Half Moon.
c/ Includes Weaver Slough, Ashley Creek, ponds between Kalispell and Flathead Lake, and ponds S.E. of Columbia Falls.
d/ Indicated pairs (IP) are defined as the total of pairs (P) and singles (S) observed during a given survey.
e/ Partial data for river only, none for McWenneger

Table 3. Canada goose pair count data, aerial surveys, northern Flathead Valley, 1987.

Date	Flathead Lake WPA[a/]			Flathead River: Kalispell-Lake[b/]			Flathead River: Col.Falls-Kalispell			Valley Potholes[c/]			McWenneger Slough			TOTALS		
	P	S	IP[d/]	P	S	IP	P	S	IP	P	S	IP	P	S	IP	P	S	IP
March 27	56	20	76	84	34	118	9	0	9	5	5	10	12	1	13	166	60	2.26
April 10	44	19	63	44	43	87	4	3	7	5	4	9	12	5	17	109	74	183
April 17[e/]	30	13	43	21	18	39	-	-	-	3	1	4	-	-	-	-	-	-
April 30	65	20	85	49	30	79	5	5	10	5	6	11	9	4	13	133	65	198

a/ Flathead Lake Waterfowl Production Area: also includes all of Flathead Lake north of Deep Bay on the west and Woods Bay on the east.

b/ Also includes the following off-river or adjacent sloughs: Church, Egan Fennon Half Moon

c/ Includes Weaver Slough, Ashley Creek, ponds between Kalispell and Flathead Lake, and ponds S.E. of Colubia Falls.

d/ Indicated pairs (IP) are defined as the total of pairs (P) and singles (S) observed during a given survey.

e/ Partial data for river onlu, none for McWenneger.

Table 4. Numbers of Canada goose indicated pairs and nests, late March through mid April, northern Flathead Valley, 1984-1987.

Area	Year	Indicated Pairs[a/]	Known Nests	P/N Ratio	Predicted Nests + or - % of Known Nests)[b/]
North Shore	1985	33	35	0.94	-17.1
	1986	48	48	1.00	-12.5
	1987	70	49	1.42	+24.5
	$\bar{x}$	50	44	1.14	
River below Kalispell	1985	82	63	1.30	t9.5
	1986	65	73	0.89	-24.7
	1987	103	72	1.43	+20.8
	$\bar{x}$	83	70	1.19	
River above Kalispell	1985	7	9	0.78	0.0
	1986	5	8	0.63	-0.25
	1987	8	9	0.89	-0.11
	$\bar{x}$	7	9	0.78	

a/ Mean annual data.
b/ This value represents the under- or over-estimation of nesting effort which would have resulted from using annual mean data and mean P/N ratios for each area.

observations in 1985 were verified as corresponding closely with snag nest locations identified through the use of the helicopter in 1986.

Nests

A total of 136 nesting attempts were recorded at 134 nest sites in 1986 (Appendix I), and 134 nesting attempts were recorded at 132 sites in 1987 (Appendix J). The distribution of nesting effort by area and by nest type (Tables 5 and 6) were similar to that recorded in 1985 (Casey et al. 1986). Muskrat lodges or aquatic vegetation mats ($\bar{x}$ = 22.2 percent), island ground sites ($\bar{x}$ = 22.2 percent), and hollow-topped cottonwood snags ($\bar{x}$ = 18.7 percent) were the most common nest sites used for these two years. Tree nests built by other species (primarily osprey), and eroded delta stumps, made up 15.4 and 12.0 percent of the nests, respectively.

Most nests (annual mean = 89.9 percent) in all years were found from Kalispell downstream to (and including) the north shore of the lake. An average of 37 nesting attempts (35.2 percent of the annual nesting effort), occurred on the north shore (Table 7). In contrast, an average of seven nests (6.0 percent of the annual nesting effort) were found along the river reach above Kalispell. Nest totals for the river portion of the study area were heavily skewed toward the downstream portion, primarily due to the high number of snag nests in that river stretch.

Elevated nest sites are a very important component of the habitat available to geese in the northern Flathead Valley, averaging 54.3 percent of all nests for the four years of the study (range = 52.7 - 55.5 percent). The relative frequency of nest types varied little on an annual basis, particularly for the latter three years of the study (Figure 9). Most differences in the frequency of particular nest types by year can be attributed to search efforts. The percentage of both snag and marsh nests increased as the techniques needed to identify these hard to locate sites improved.

A variety of elevated nest sites were used throughout the study area. Most of the tree nests (other than snags) were in nests built by ospreys in previous years. One bald eagle nest was used by geese each year. Two pairs occupiednests built by great blue herons. One pair nested at a site reported as an active golden eagle (*Aquila chrysaetos*) nest in 1978 (USFWS, unpubl. data). Three nesting attempts occurred in nests built by red-tailed hawks. The remaining tree nests were in the broken tops of natural snags.

In addition to the known active nests, we recorded geese on a variety of additional elevated sites during our elevated nest inventory efforts each year. These included five or more nests

Table 5. Summary of Canada goose nest type and fate, by location, northern Flathead Valley, 1986.

Location	Nest Type: Ground	Tree	Structure	Stump	Hatched	Failed Due To: Predation	Flooded	Abandonment	Wind	Unknown	% Nest Success (Known Fate)
Flathead Lake WPA (n=42)											
Delta Island	1				1						100
Dredged Islands	7		1			8					0
Mud flats (Delta)	7			17	13		3	1		7	76
WPA East	6	3			5			2		2	56
SUBTOTAL	21	3	1	17	19	8	3	3	—	9	64
Flathead Lake Somers Bay, Islands	3		3		5					1	100
Flathead River (n=77)											
Hwy 2-Flthd. Lake[a]	25	41	2	1	40	6		3	2	18	78
Col. Falls-Hwy 2	4	1	3		6	1				1	86
SUBTOTAL	29	42	5	1	46	7	—	3	2	19	80
McWenneger Slough[b]	7				2	1		1		3	50
Weaver Slough/ Ashley Cr.		2	2		2					2	100
TOTALS (N=136)	60	47	11	18	74	16	3	7	2	33	73

a/ Includes Fennon, Egan, Church and Half Moon Sloughs, Hodgeson Lake.
b/ Includes one nest at Montford Slough.

Table 6. Summary of Canada goose nest type and fate, by location, northern Flathead Valley, 1987.

Location	Nest Type				Hatched	Failed Due To:			Unknown	% Nest Success
	Ground	Tree	Structure	Stump		Predation	Flooded	Abandonment		(Known Fate)
Flathead Lake WPA (N=41)										
Delta Island	1								1	
Dredged Islands	9					9				0
Mud flats (Delta)	1			17	2	11	2	1	2	13
WPA East	8	3	1		6	1			5	50
West Boundary			1						1	
SUBTOTAL, LAKE	19	3	2	17	8	21	2	1	9	25
Flathead Lake										
Somers Bay, Islands	6		2		3			2	3	60
Flathead River										
Hwy 2-Flthd. Lake[a/]	26	38	3	1	16	8		2	43	59
Col. Falls-Hwy 2	5	1	4		1	1	2			25
SUBTOTAL, RIVER	31	39	7	1	17	9	2	2	46	55
McWenneger Slough	4					1		2	1	0
Weaver Slough/ Ashley Cr.		1	2						3	
TOTALS (N=134)	60	44	13	18	28	30	4	7	66	41[b/]

a/ Includes Fennon, Egan, Church and Half Moon Sloughs, Hodgeson Lake.
b/ This observed success rate is biased (low) due to the small number of known-fate tree nests, which averaged 90 percent successful in 1985 and 1986.

Table 7. Number of known Canada goose nesting attempts, by area, northern Flathead Valley, Montana, 1984 to 1987.

Area	1984[a]	1985	1986	1987
Flathead WPA	15	30	42	41
Somers Bay	1	5	6	8
Flathead River				
Kalispell - Lake[b]	26	62	69	68
C. Falls - Kalispell	1	9	8	10
McWenneger Slough	1	0	7	4
Weaver Slough/Ashley Creek	___	2	4	3
TOTALS	44	108	136	134

a/ Nest search efforts in 1984 were limited as compared to other years.

b/ Includes Fennon, Egan, Church and Half Moon sloughs, Brosten's Pond (Hodgeson Lake).

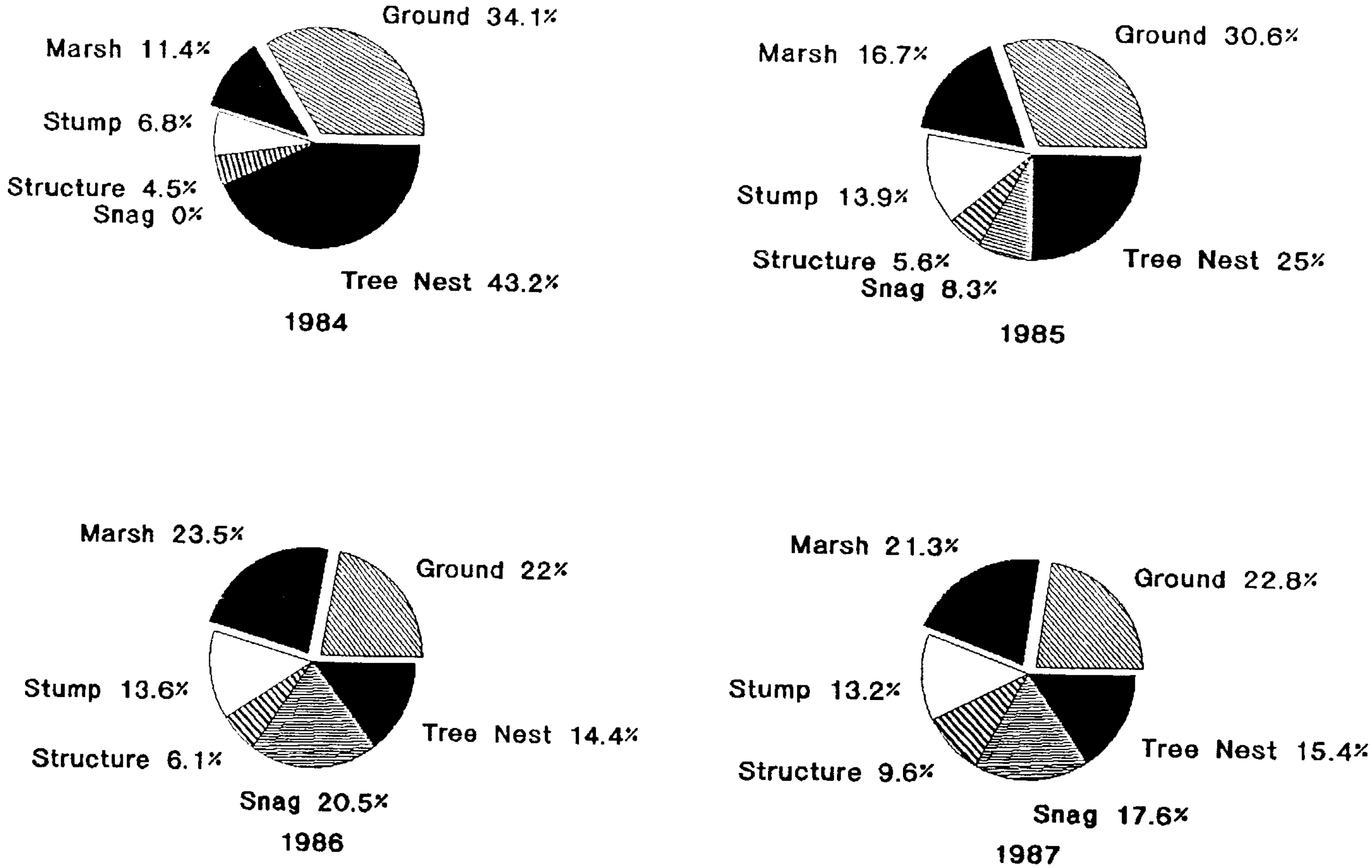


Figure 9. Annual percentage of Canada goose nests by type, northern Flathead Valley, 1984-1987.

from which geese were displaced by ospreys before we were able to verify if the nests were active; and many other sites on which geese were seen only once or twice either early or late in the nesting period which were otherwise vacant. We assumed these latter observations represented either non-breeding, "exploring" sub-adults or failed nesters.

Nest Success

As in previous years, marshnests and other groundnests had lower success than elevated types (Tables 8 and 9). Stump nests fared poorly in 1987 (Table 8), with predation being the primary cause of nest failure.

The average rate of nesting success for known-fate nests, 1984-1987, was 61 percent. Percent nesting success for elevated nest sites, particularly tree nests, was usually difficult to ascertain. For this reason, there were fewer known-fate tree nests each year ($\bar{x}$ = 41 percent) than for other nest type categories (e.g., island ground, 81 percent; marsh, 77 percent; stump, 80 percent: structure, 53 percent). Therefore, overall nesting success was underestimated because tree nests tend to be the most successful. In order to develop a realistic estimate of nesting success for each year, we applied success (and failure) rates to the known number of nests, for each nest type. For example, if we found 100 nests (50 ground, 50 tree) and knew 16 of 40 ground nests hatched, and 8 of 10 tree nests hatched, our observed success rate would be (24/50) = 48 percent. By applying the respective nest success rates by type, however, we would estimate that (16/40)(50) = 20 ground nests hatched, and (8/10)(50) = 40 tree nests hatched. Our revised estimate of overall nesting success would be (60/100) = 60 percent.

Our revised average estimate of nesting success was 68 percent. Estimated nesting success varied widely between years, from a high of 82 percent in1984 to a low of 50 percentin1987. If tree nests were as successful in 1987 as they had been in the previous two years (90 percent hatched), rather than the 67 percent figure we calculated. from a small sample (6 of 44 nests), then hatching success was still just 58 percent for 1987 (Table 10). Predation was the most common cause of nest failure ($\bar{x}$ = 23 percent) each of the four years (Figure 10), but may have been somewhat overestimated. Abandoned nests are frequently destroyed by scavenging predators, and are easily classified incorrectly (Hanson and Eberhardt 1971). The fact that we classified an increasing number of nests as abandoned over the four years (Figure 10) reflects our increased precision in timing revisits to nest sites.

Nesting success varied dramatically between areas and between nest types. Nesting success along the north shore of the lake varied from 31 percent to 78 percent over the four years, with an

Table 8. Summary of Canada goose nest fate by nest type, northern Flathead Valley, 1986.

		Failed Due To			Un	% Succes
		on	Flood	Aban nm		Known Fa
Ground (N=60)						
Marsh (n=31)	10			5	9	45
Island (n=29)	17		2	[illegible]	4	68
SUBTOTAL	27		2	[illegible]	13	57
Elevated N=75)						
Stump (n=18)	12		1	1	4	86
Structure (n=10)	6	1			3	86
Tree (n=47)	28	2			17	93
SUBTOTAL	46	3	1	1	24	90
TOTAL	73	15	3	7	87	74

Table 9. Summary of Canada goose nest fate by nest type, northern Flathead Valley, 1987.

Nest Type	Hatched	Failed Due To: Predation	Flood	Abandonment	Unknown	% Success (Known Fate)
Ground (N=60)						
Marsh (n=29)	5	13		3	8	24
Island (n=31)	15	4	2	2	8	65
SUBTOTAL	20	17	2	5	16	52
Elevated (N=75)						
Stump (n=18)	2	11	2	1	2	13
Structure (n-13)	2			1	10	67
Tree (n-45)	4	2			38	67
Subtotal	8	13	2	2	48	32[a]
TOTAL (N=135)	28	30	4	7	64	41[a]

[a] These success rates are biased (low) based on the low number of known fate tree nests this year. Tree nests averaged 90 percent successful in 1985 and 1986.

Table 10. Observed and expected[a/] nesting success for Canada geese in the northern Flathead Valley, 1984-1987.

Fate	1984		1985		1986		1987	
	obs. (%)	Exp. (%)	Obs. (%)	Exp. (%)	Obs. (%)	Exp. (X)	Obs. (%)	Exp. (%)
Hatched	12 (.75)	36 (.82)	41 (.55)	66 (.63)	74 (.73)	101 (.74)	28 (.41)	78 (.58)
Failed due to:								
Predaticm	4 (.25)	7 (.16)	27 (.36)	32 (.30)	16 (.16)	20 (.15)	30 (.43)	40 (.30)
Abandonment		1 (.20)	2 (.30)	3 (.30)	7 (.07)	9 (.07)	7 (.10)	12 (.09)
Flooding			2 (.03)	2 (.03)	3 (.03)	3 (.02)	4 (.06)	4 (.03)
Wind			2 (.03)	2 (.03)	2 (.02)	2 (.02)		

a/ Expected values calculated by applying observed rates for each nest type to the total nests for that type each year, then summing all nests by fate.

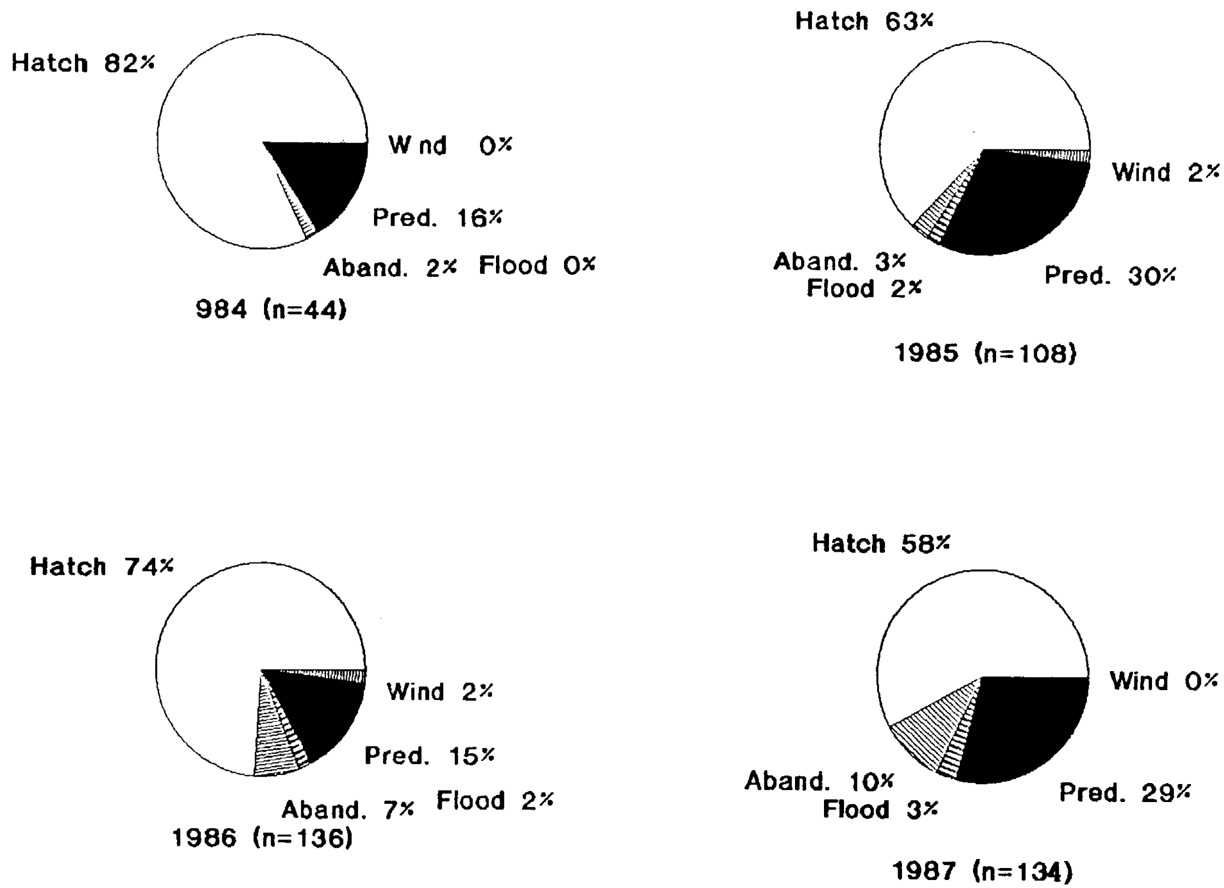


Figure 10. Annual percentage of Canada goose nests by fate, northern Flathead Valley, 1984-1987.

average of 60 percent. The predominance of tree nests on the lower river reach also led to higher'nest success in that reach (mean = 67 percent, range 59 to 78) as compared to the reach above Kalispell (mean = 48; range = 25 to 86). Tree nests had the highest success rate (mean = 88 percent, 1985, 1986) of all nest types throughout the study area.

Nesting success was lowest (mean = 39 percent, range = 14 to 75) for ground nests in marsh habitats (Table 11). primarily due to predation. We were likely to have consistently underestimated the number of such nests in the study area. Muskrat (Ondatra zibethicus) activity may have destroyed all signs of nesting by the time we searched the muskrat lodges which offered the best nesting sites: we often had to dig 10 to 30 cm into fresh lodges to discover evidence of nesting.

High predation rates of island ground nests was cited as the cause of low nesting success elsewhere in the Flathead Valley in 1985 (Matthews et al. 1986). Thirty-eight percent of the 89 known-fate island ground nesting attempts in our study area failed. Four of these flooded and 25 failed due to predation. Craighead and Stockstad (1961) determined the major causes of nesting failure for geese in the Flathead Valley were predation and desertion; Geis (1956) attributed most predation losses (90 percent) to ravens (Corvus corax) or crows (Corvus brachyrhynchos). Black-billed magpies (Pica pica) are also a common avian predator in the Flathead Valley. A wide variety of mammals have been recorded as known or probable predators of goose nests in the Flathead Valley, including mink (Mustela vison), badger (Taxidea taxus), striped skunk (Mephitis mephitis), coyote (CAnis latrans), raccoon (Procyon lotor), and domestic dog (Geis 1956, Mackey et al. 1985). We documented seven failures due to bird predation and eight due to mammal predation, but were unable to determine the predator type at 61 nesting attempts which failed due to predation. We observed sign of coyote, dog, raccoon, and skunk on nesting islands, and both crows and ravens were common throughout the study area.

We analyzed clutch size data for different nest types in 1985. Clutch size for 18 ground nests was 5.83 +1.51, and clutch size for 26 elevated nests was 5.31 +1.54. This difference, however, was not significant ($p=0.27$) using a grouped t-test (Snedecor and Cochran 1967).

Nest Chronology

Results of the egg-floating experiment indicated that the egg stages identified by Westerskov (1950) are not of equal length, as had been assumed in the previous analyses of nest chronology in the Flathead Valley (i.e., Mackey etal. 1985, Casey et al. 1986). Revised stages, as determined by the experiment, and their length

Table 11. Observed fate of Canada goose nests, by type and year, northern Flathead Valley, 1984-1987.

Nest Type	Observed Nest Success by Year (%)				
	1984	1985	1986	1987	$\bar{x}$
Ground - Island	72	50	68	65	63.8
Ground - Marsh	75	14	43	24	39.0
Stump		82	86	13	60.3
Structure	50	50	88	67	63.8
Tree	-	87	88	66	80.3

in days as average for the five eggs in the experimental clutch, were as follows:

Stape	Description	Length in Days
	Laying	8
1.0	Egg on bottom, horizontal	3
1.5	Egg on bottom, 45 degree angle	6
2.0	Egg on bottom, vertical	10
(2.5)	Egg barely bounces on bottom	(2)
(3.5)	Egg floats vertically, just below the surface	(1)
4.0	Egg breaks surface, vertical	4
4.5	Egg breaks surface, 45 degree angle	3
6.0	Pipped	1

These revised stages were used in the development of the nest chronology curves (Figure 11). The data collected from 1986 and 1987 ground nests fit the experimental data with a high degree of accuracy, and allowed us to plan our nest visits in such a way that we arrived at the nest the day it hatched in several instances.

Ground nest initiation in the study area during the four years spanned from March 12 through May 2, with the annual peaks occurring from March 21 through April 15. These data are similar to the usual peak reported by previous regional studies (Geis 1956, Craighead and Stockstad 1964, Mackey et al. 1985). Data from 1985 indicated that elevated nests were the earliest nests started, with the WPA stump nests apparently being initiated later than the other elevated sites (Figure 12). This delay at the mudflat stumps may be due to the late date (April 4) that ice-out occurred at the lake in 1985.

Analysis of our 1984 and 1985 data indicated that water level fluctuations of as much as 8 ft can occur between the beginning of nest initiation and the end of the hatching period, at least in some years (Casey et al. 1986). The timing and extent of water level fluctuations over the four-year study period, and their relationship to nesting success, are discussed later in this report.

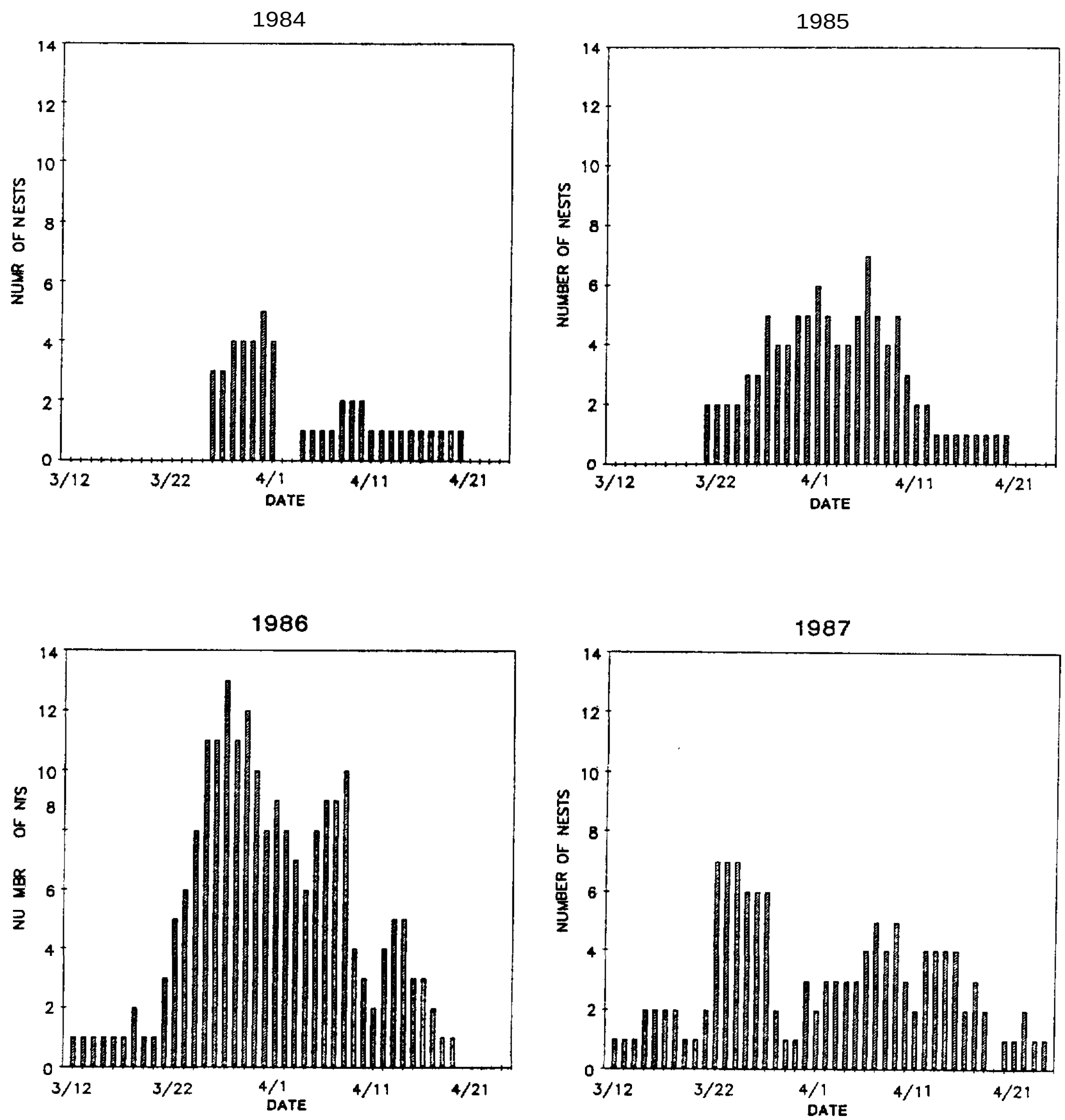


Figure 11. Canadagoose ground nest initiation curves, northern Flahtead Valley, 1984-1987.

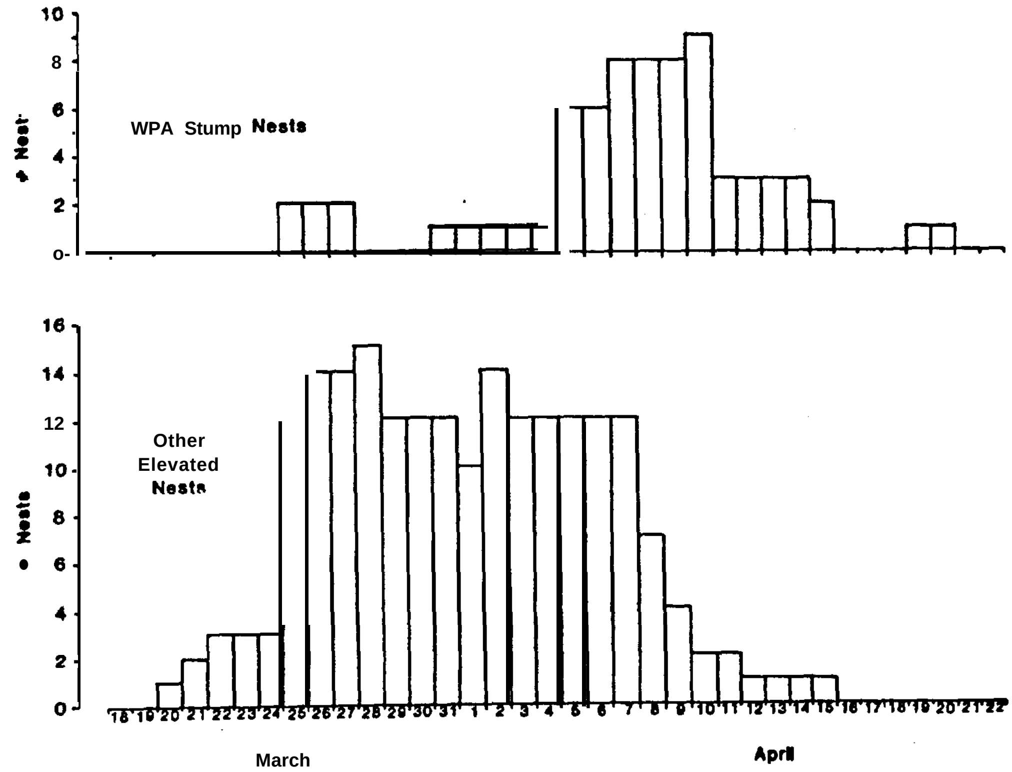


Figure 12. Estimated initiation dates, stump nests and other elevated nest sites, used by Canada geese, northern Flathead Valley, 1985.

Nest Site Habitat Measurements

Ground Nests

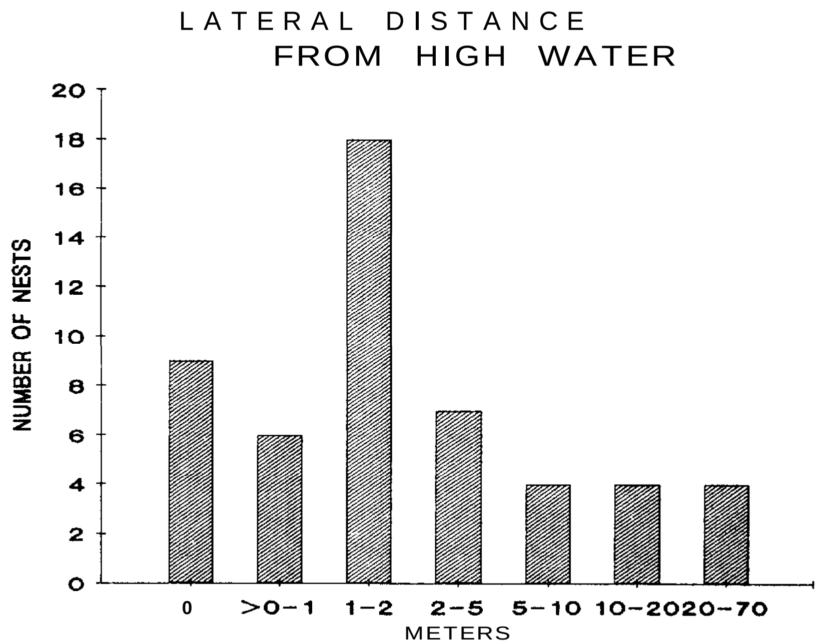
Ground nests analyzed included those sites not found on artificial structures or in the marsh cover type. Fifty-six (39 percent) of 144 ground nest sites were analyzed. All but one ground nest were found on islands.

Data from 52 ground nests were combined to describe nest sites in relation to the seasonal HWM (Figure 13). Nine nests (17 percent) were located at or below the HWM. Seventy-one percent of the ground nests were found less than 1 m above the HWM. Most (63 percent) of the ground nests were less than 2 m horizontal distance from the HWM (Figure 13). The large percentage (71 percent) of nests found less than 1 m above the HWM indicates the potential for loss of nest sites due to flooding and erosion. Two nest sites on the upper river were lost when the supporting bank was washed away during high flows in June 1985. Additionally, all but one of the ground nests found on the two delta islands were lost due to erosion. The remaining island was lost during the 1987 full pool period.

Stem density (stems per m^2) at nest sites and percent overhead cover was recorded at 54 nest sites. The average number of stems found at the nest site (6.5 +11.7) and 5 m from the nest (6.7 +6.7 was similar. The average overhead cover was 39 (+36.7) percent cover. Shrubs (31 percent) and trees (19 percent) provided the largest percent cover; grass and forbs provided minor cover (Table 12).

To describe some of the differences of nest sites within cover types, we analyzed the nests in each cover type separately. Expected differences between cover types were verified by these measurements. Dense shrub sites had significantly greater shrub coverage (45 percent) than the sparse shrub sites (15 percent; t-test, $p<.05$). Nests in the forested cover types had a significantly greater amount of overhead cover (64 percent) than those in shrub cover types (14 percent; t-test, $p<.05$).

Data from all ground nests were combined to describe nest distribution by cover types (Figure 14). Most nests were found in the deciduous forest type (43 percent) or the dense shrub type (29 percent). Several nests were also found in the sparse shrub type (16 percent). Very few nests were found in the herbaceous (5 percent), unvegetated (2 percent), or mixed forest (5 percent) types. This analysis included nests found on the upper river portion (n=38), the lower river (n=4), the delta islands (n=10), and Somers Bay on the north shore As these areas are quite distinct vegetatively, we analyzed the nest distribution data for the upper river in more detail to test if specific cover types were selected.



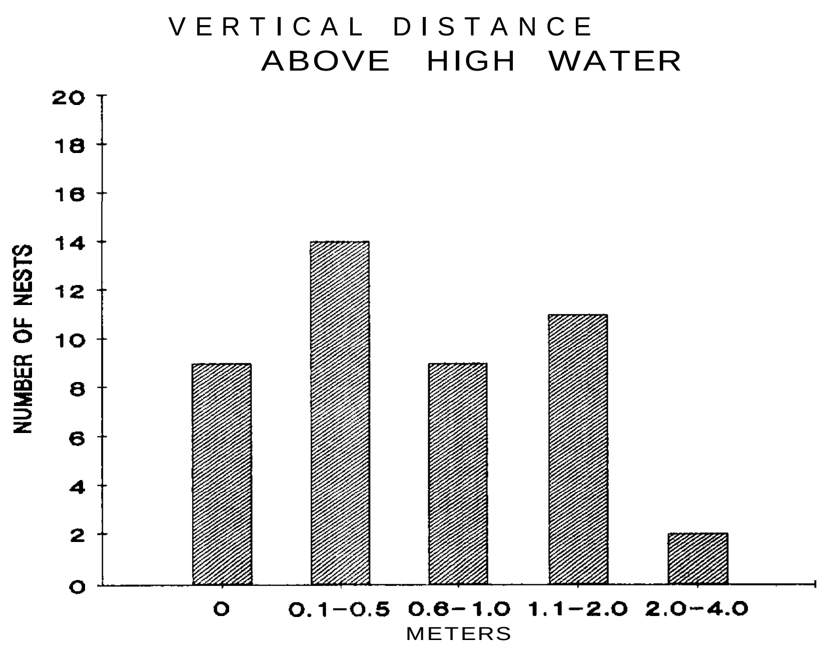


Figure 13. **Canada goose groundnestlocations in relation to the seasonal high water mark, northern Flathead Valley, 1984-1987.**

Table 12. Percent cover by vegetation classes for 54 Canada goose ground nests, northern Flathead valley, Montana.

					bare	
Mean	14.13	13.52	30.76	19.26	20.85	46.43
Standard Deviation	20.66	18.62	27.82	29.15	26.50	25.36
Minimum	0.00	0.00	0.00	0.00	0.00	5.00
Maximum	75.00	77.00	97.00	95.00	91.00	96.00

COVER TYPES
ALL GROUND NESTS

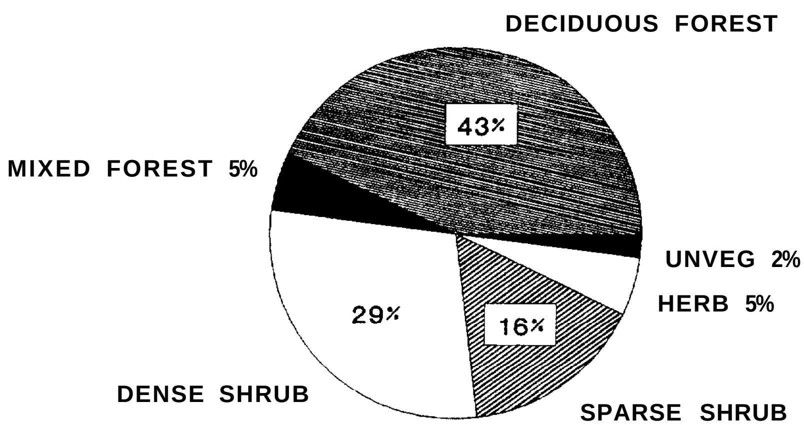


Figure 14. **Canada goose greound nest distribution by cover type, northern Flathead Valley, 1984-1987.**

Ground Nest Site Selection. Island groundnests in upper river area were found in eight cover types (Table 13). The largest proportion of nests (29 percent) were found in the deciduous forest-immature cover type.

The distribution of nests by cover types was significantly different from the expected frequency based on the percent cover types found on all islands. Islands used by nesting geese were significantly different from islands not used for nesting (Chi-square = 23.31; $p<.002$). Eight cover types were tested. Less acres of deciduous forest-mature stands (Chi-square = 12.13; $p<.001$). and more acres of herbaceous cover type (Chi-square = 4.98; $p<.05$) were found on nest islands.

No significant difference was found in the distribution of nests by cover types and the distribution of cover types on the nest islands (Chi-square = 11.12; $p<0.13$). However, significant differences were approached for two cover types. Fewer nests were found in deciduous forest-mature stands and sparse-shrub stands suggesting a slight selection against these types.

Distribution of nests by cover types was significantly different from the distribution of cover types found on all islands less than 30 acres (Chi-square = 25.22; $p<.001$). This difference was influenced by selection or avoidance of three particular cover types. Fewer nests were found in deciduous forest-mature and sparse shrub than expected based on the percent of these cover types available. More nests were found in deciduous forest-immature than expected based on the percent available.

Whether geese select nesting islands based on their size was determined through an analysis of 32 islands used during at least one of the four years for nesting, and 118 which were not used. There was no significant difference ($p = 0.58$) between the mean size of nesting islands (5.97 acres, +6.96), and those not used (mean = 8.37, +23.68). Analysis of distribution of nesting islands by size class revealed that geese use islands in relation to their availability (Figure 15), except for those islands in the smallest size category (<0.51 acres). Geese apparently select against the smallest islands ($p<0.05$), perhaps due to the tendency for such sites to be very sparsely vegetated, and their susceptibility to flooding.

Marsh Nests

A total of 30 nest sites found in the marsh cover type were sampled. Eight nests were found on man-made islands in dredged ponds on the WPA. Although these ponds were surrounded by cattails, habitat measurements for the nest sites did not reflect true marsh site conditions and thus were treated separately. Twenty-two nests were found in off-river sloughs or ponds

Table 13. Cover type distribution by nest (number) and island (acres) for island ground nests found on the upper Flathead River.

Cover Type	Number of Nests	(I)	Nest Islands N=25	(%)	Non-Nest Islands N=102	(%)	All Islands N=127	(%)
Deciduous Forest - mature	2	(5)	19.75	(13.4)	82.26	(24.0)	102.21	(20.8)
Deciduous Forest immature	11	(29)	22.88	(15.5)	54.64	(15.9)	77.52	(15.8)
Mixed forest	2	(5)	5.92	(4.0)	20.83	(6.1)	26.75	(5.4)
Dense shrub - cottonwood/willow	9	(24)	38.37	(26.1)	64.05	(18.6)	102.42	(20.8)
Dense shrub - mixed	5	(13)	11.02	(7.5)	24.11	(7.0)	35.13	(7.1)
Sparse shrub	5	(13)	34.05	(23.1)	85.02	(24.7)	119.07	(24.2)
Herbaceous	3	(8)	11.25	(7.6)	9.08	(2.6)	20.33	(4.1)
Unvegetated	1	(3)	3.99	(2.7)	4.08	(1.2)	8.07	(1.6)
Total	38		147.23		344.27		491.50	

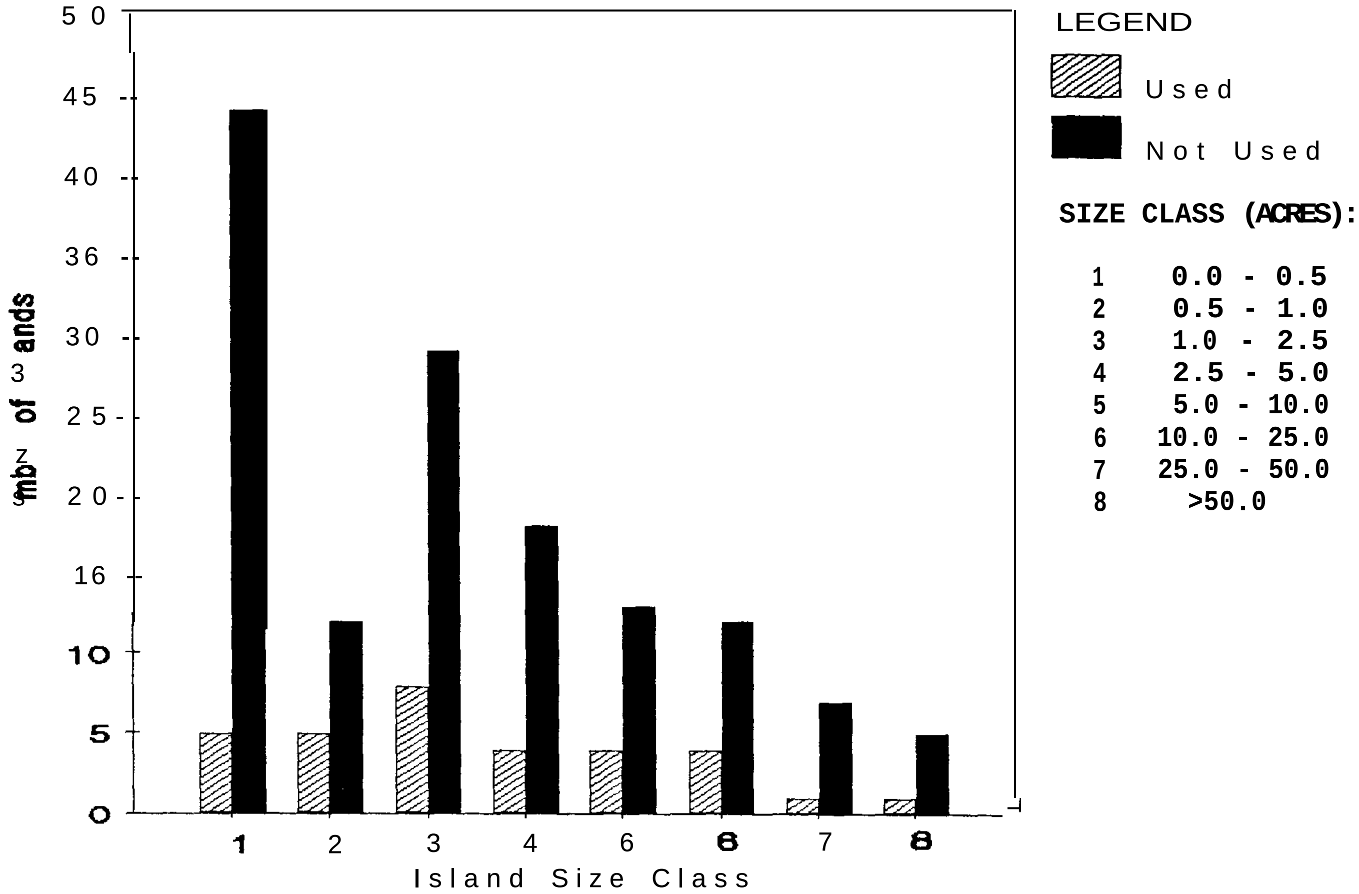


Figure 15. Canada goose nesting use of river and lake islands, versus availability by size class, northern Flathead Valley.

including Brosten's Pond, McWenneger Slough, and Egan Slough. Generally these areas are not influenced by water level fluctuations and supported dense stands of cattails and bulrushes.

Goose nests found in the pond or slough marsh habitat were located on muskrat lodges or vegetation mats. Most vegetation mats were old muskrat lodges, however, in a few cases, nests were found on mats of dead cattails or bulrushes. More than half of the nests (55 percent) were less than 10 m from open water (Figure 16). Most nests (64 percent) were at least 20 m from upland areas, either pastures or herbaceous meadows (Figure 16).

The lodges or mats used by geese were an average 1.8 m in diameter and were generally surrounded by water that averaged 0.6 m deep. Cattails and/or bulrushes surrounding the nest site averaged 1.7 m in height above the water level (Table 14).

Analysis of transect data described the type and amount of vegetation cover available at nest sites (Table 15). Emergent vegetation including cattails and bulrush provided 40 percent of the cover. Aquatic vegetation (22 percent) included both floating (Nuphar variegatum Lemna spp.) and submerged vegetation (Potamogeton spp., Elodea spp., Ceratophyllum demersum). The open water near nests (69 percent) had limited aquatic vegetation growth. Litter (34 percent), consisting of dead cattail leaves, also provided cover.

Stump Nests

Measurements were taken for a total of 22 stumps used as nest sites in 1985 and/or 1986 (Table 16). These included 11 used only in 1985, six used only in 1986, and four used both years. These stumps were an average 3.4 m in circumference (range 2.4 - 5.5 m), and 1.9 m in height (range 0.6 - 2.9 m). Average dimensions of the depression or cavity actually used for nesting were 47 x 36 cm and most had a rim above the nest. These rims had an average high point of 75 cm and an average low point of 9 cm. The average elevation of the nests was 2,891.2 ft. Only two of the nests were above the elevation of full pool (2,893 ft). A majority (91.5 percent) of the 188 stumps measured in 1986 had top elevations below full pool (Figure 17). The percent of stumps above full pool elevation was similar for those used as nest sites (10 percent) and those not used (8.4 percent).

Several discriminant function analyses were performed in order to determine those habitat variables which most influenced selection for stumps by geese. Aspect data were converted to numeric values for this analysis. For the initial run, all data collected for 188 stumps were entered, with eight types of stumps identified. These were: 1) used in 1985; 2) used in 1986; 3) used both years: 4) look usable, not used; 5) flat or concave top; 6) easily modified; 7) eroded into a tube; and 8) osprey

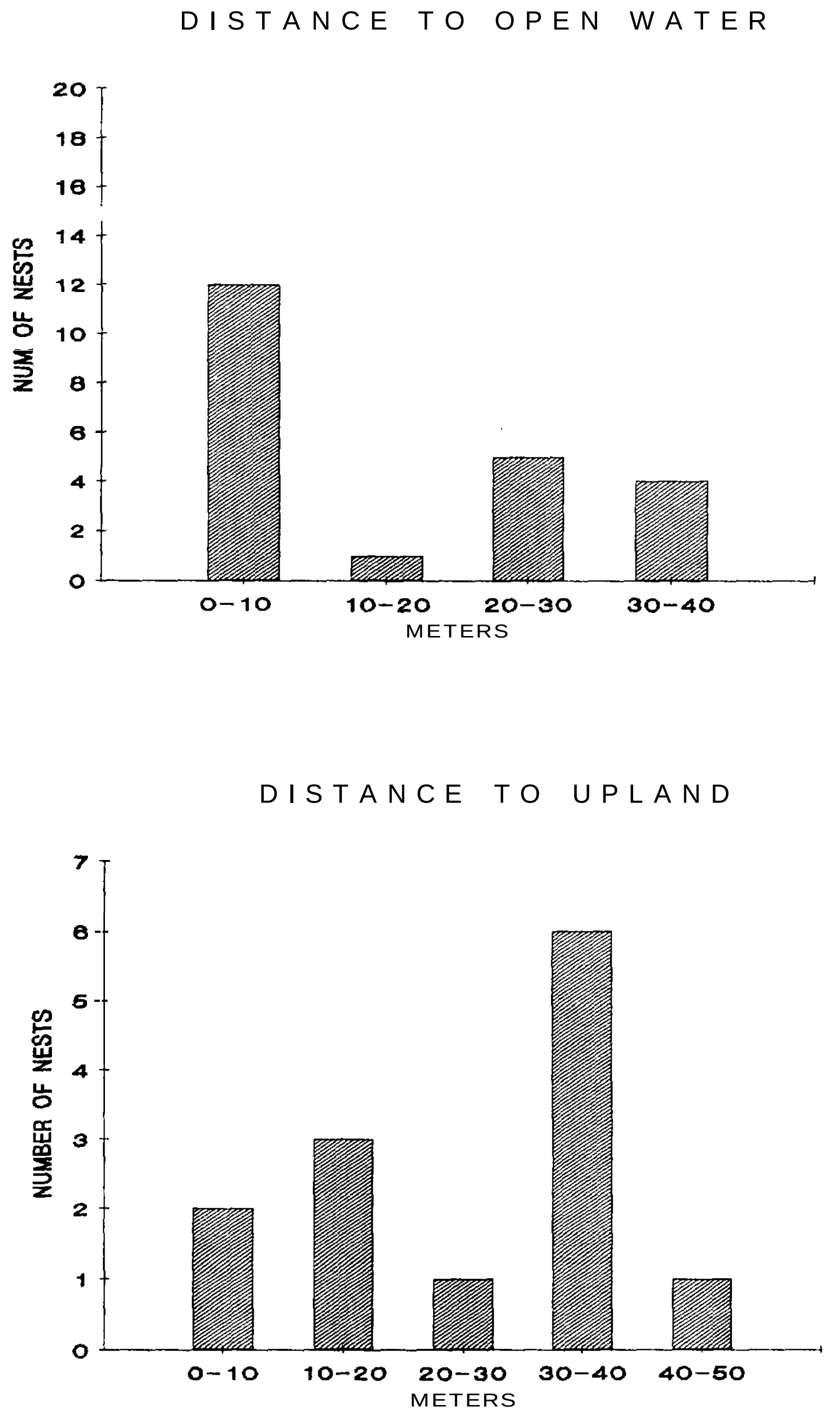


Figure 16. **Distance of Canada goose marsh nests to open water and upland vegetation, northern Flathead Valley, 1984-1987.**

Table 14. Habitat characteristics at marsh nest sites of Canada geese, northern Flathead Valley, Montana, 1984-1987.

	Distance Open Water (m)	Distance Upland (m)	Lodge/Mat Diameter (m)	Water Depth (m)	Vegetation Height (m)
Sample size	22	14	13	7	8
Mean	15.65	25.36	1.84	0.63	1.70
Standard Deviation	13.62	11.72	0.20	0.24	0.35
Minimum	0.10	8.20	1.00	0.30	1.10
Maximum	40.00	50.00	3.60	1.00	2.30

Table 15. Vegetation cover (percent) by class for 21Canada goose marsh nest sites, northern Flathead Valley, Montana.

	Emergents	Aquatics	Forb	Shrub	Water	Litter
Mean	40.14	22.19	2.05	0.24	68.90	34.19
Standard Deviation	17.17	26.14	5.43	1.09	26.17	19.11
Minimum	17.00	0.00	0.00	0.00'	0.00	12.00
Maximum	81.00	76.00	18.00	5.00	90.00	82.00

Table 16. Habitat characteristics of stumps used by Canada geese as nest sites, northern Flathead Valley, Montana.

Number	Circum (m)	Rim High (cm)	Rim Low (cm)	Cavity L (cm)	Cavity W (cm)	Aspect[a]	Stump Height (m)	Nest Elevation
B16	2.60	22	6	32	27	se	1.47	2,891.7
B17	2.95	--	--	35	45	--	2.26	2,893.5
B20	4.05	61	10	37	27	sw	1.15	2,890.7
B21	2.36	38	12	25	34	s	1.92	2,892.8
B22	3.03	--	--	32	51	sse	1.02	2,889.7
B23	4.48	108	11	65	40	--	2.08	2,890.8
B24	3.68	--	--	29	43	--	0.63	--
B25	3.65	102	10	50	32	wsw	2.48	2,893.1
B26	3.78	32	3	50	35	s	1.62	2,891.9
B27	3.35	--	--	30	34	--	1.00	2,891.3
B28	---	--	--	--	--	--	----	2,890.3
B29	3.20	95	20	45	40	nw	2.15	2,891.0
B30	2.47	47	1	25	30	nw	1.99	2,891.3
B31	---	--	--	22	43	ne	2.52	2,890.2
B32	4.60	95	20	85	35	w	2.23	2,891.2
B41	3.36	70	5	69	46	e	2.11	2,891.7
B43	2.97	72	0	48	24	wsw	2.06	2,890.7
B44	3.12	126	15	52	33	e	1.78	2,889.2
B45	3.84	64	5	49	49	nnw	1.16	2,889.8
B46	2.72	32	9	30	29	e	0.90	2,890.5
B47	2.62	60	14	34	40	nnw	1.84	2,891.5
B55	4.37	174	0	53	51	ssw	2.84	2,891.4

[a] Orientation of low point in the rim.

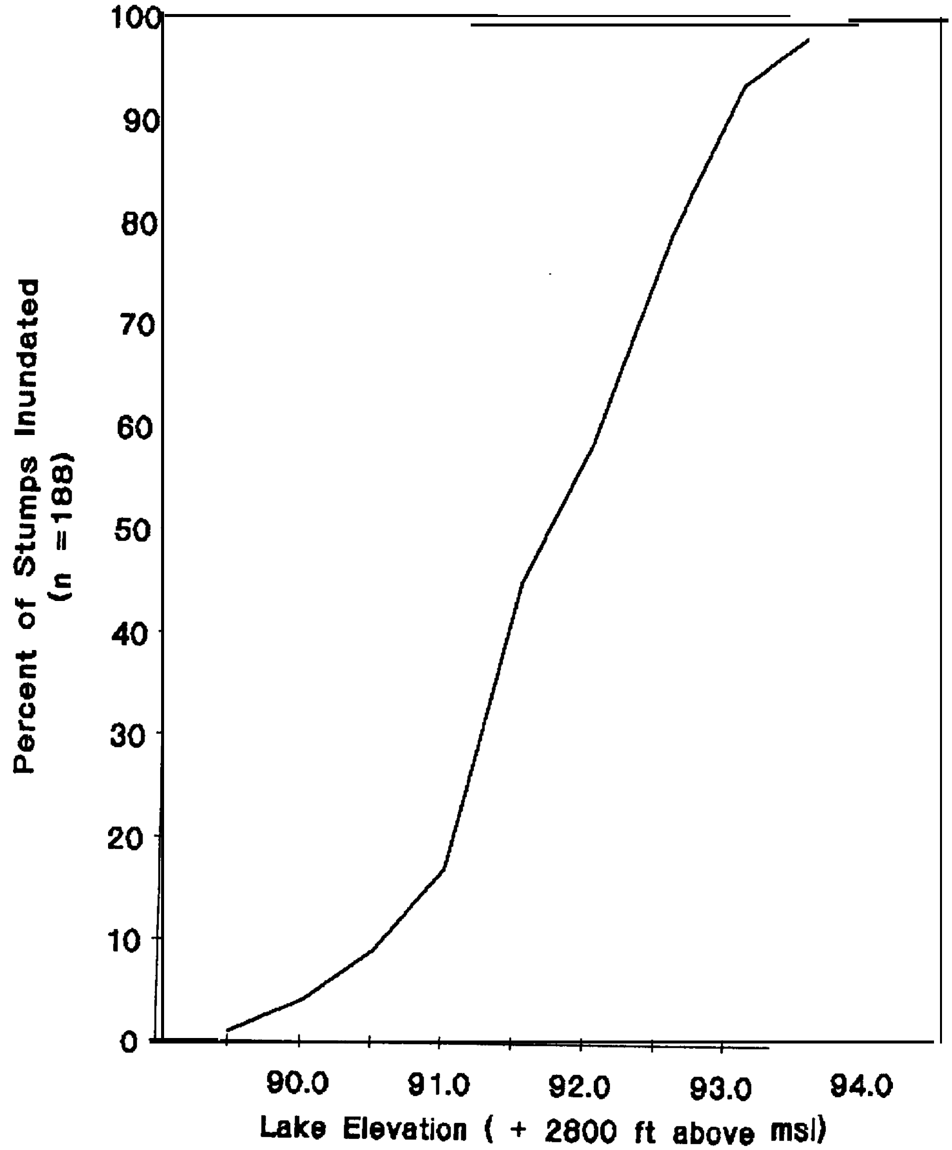


Figure 17. Cumulative distribution, top elevations of selected stumps, Flathead River delta.

nest on a stump. Categories (4) and (6) were included to test whether the observers were able to differentiate suitable stumps in the field, and to gain a feel for the number of potential sites for enhancement, respectively. The model was able to classify 68 percent of the stumps correctly into these eight categories. By combining the categories into used (1, 2, 3), potential (4, 5, 6), tubes (7) and osprey nests (8), the power of the model to discriminate types was greatly improved; 86 percent of the stumps were correctly classified. Percent of rim at back height, cavity length, low point in the rim, and friability (softness) were the variables which contributed the most to this analysis. By lumping categories (1 through 4) and (5 through 8), the model predicted groups with 91 percent accuracy, with height of rim, cavity length, and circumference being the most important variables used to discriminate. Eliminating tubes and osprey nests from the analysis improved the performance of the modeleven further (94 percent correct), with cavity dimensions, rim height and circumference once again contributing the most.

These analyses indicated that geese select particular characteristics of stumps they use as nest sites. Stumps used for nesting are larger (3.4 m vs. 2.4 m circumference), have larger depressions or cavities (47 x 36 cm versus 27 x 20 cm), and tend to have rims which have higher maximum heights above the depression (75 cm versus 36 cm) and lower low points (9 cm versus 15 cm) as compared with those stumps not used for nesting. The preference geese showed for larger stumps is almost certainly related to selection of larger cavities because circumference and cavity length were highly correlated ($r = 0.81$).

We compared stumps used only one year to stumps used both years, to see if any characteristics of the latter might classify them as "optimum" stump sites. When all variables were included in the model, all 16 stumps used for nesting were classified correctly. Surprisingly, the model was able to discriminate between those stumps used only in 1985 and those used only in 1986, as well as those used both years. Aspect, circumference, nest elevation and cavity length were the variables used for this run. Differences between those used one year and those used both were expected, if our assumption that consistency of use is representative of optimum conditions was valid. Stumps used both years were larger in circumference ($x = 3.8$ m) than those used only once ($x = 3.1$ m), and tended to be oriented in a southerly or westerly direction. Those used only one year tended to be oriented more randomly; several were oriented to the northwest. The importance of aspect is obscure, although it can be important for thermoregulation during the incubation period. When aspect was dropped from the analysis, only 87 percent of the nesting stumps were successfully classified by the model.

In each of the analyses, stumps misclassified as being used two years tended to have large circumference measurements (e.g., B23, 4.5 m), and stumps misclassified as being used only one year had small circumferences (e.g., B30, 2.5 m). Large, well-eroded stumps with a distinct rim and depression are apparently the sites preferred by stump-nesting geese.

All stumps which were measured were cottonwood (E. Burke, Univ. Montana, pers. commun.). This fact can be interpreted several ways: 1) all trees on the delta were cottonwoods; 2) species eroded at different rates, and only cottonwoods remain; or 3) only cottonwoods eroded in a way which left them flat or concave-topped. It is likely that the majority of trees on the delta were indeed cottonwoods, but we know from historic records and current shoreline habitats that some spruce (*Picea* spp.), birch (*Betula* sp.), ponderosa pine (*Pinus ponderosa*), or larch (*Larix occidentalis*) were also likely to be present. Whether option (2), (3) or both options listed above were in effect is unknown.

Tree Nests

Data from 52 tree nest sites were analyzed to describe habitat characteristics. Three different tree nest types used by geese were sampled including 29 raptor nests (26 osprey and three eagle or hawk nests), 14 snags, and nine live broken-top trees. All sampled nests were in cottonwood trees, and all but one were on mainland riparian benches.

Data from all three types of tree nests were combined to analyze their size and relationship to the seasonal HWM (Table 17). Nest trees had an average dbh of 0.98 m. The average distance to high water was 15.0 m, however, most (62 percent) of the trees were less than 10 m horizontal distance from the high water (Figure 18). The average height above the high water (from base of the tree) was 1.0 and most (62X) were less than 1 m above the high water mark.

Tree height and nest height data are reported separately for the three types of tree nests (Table 18). The average snag height was 13.7 m. The average live tree with dead top was 21.7 m and was similar in size to the osprey nest trees ($\bar{x}$ = 23.3 m).

Nests found in hollow snags were often well below the top of the tree as indicated by the average nest height ($\bar{x}$ = 12.4 m) compared to the average tree height ($\bar{x}$ = 13.7). Dead-top live trees often had live branches above the broken-top nest site. This explains the difference between the average tree height ($\bar{x}$ = 21.7 m) and the average nest height ($\bar{x}$ = 14.3 m). The sample size for nests in dead-top live trees was too small to make any meaningful comparisons to osprey nests used by geese.

Table 17. Characteristics of tree nest sites used by Canada geese, northern Flathead Valley, Montana, 1984-1987.

Variable	Diameter Breast Height (m)	Distance High Water (m)	Height High Water (m)
Sample size	52	51	45
Mean	0.98	15.01	1.04
Standard Deviation	0.20	23.03	0.69
Minimum	0.59	0.0	0.0
Maximum	1.48	100.0	3.40

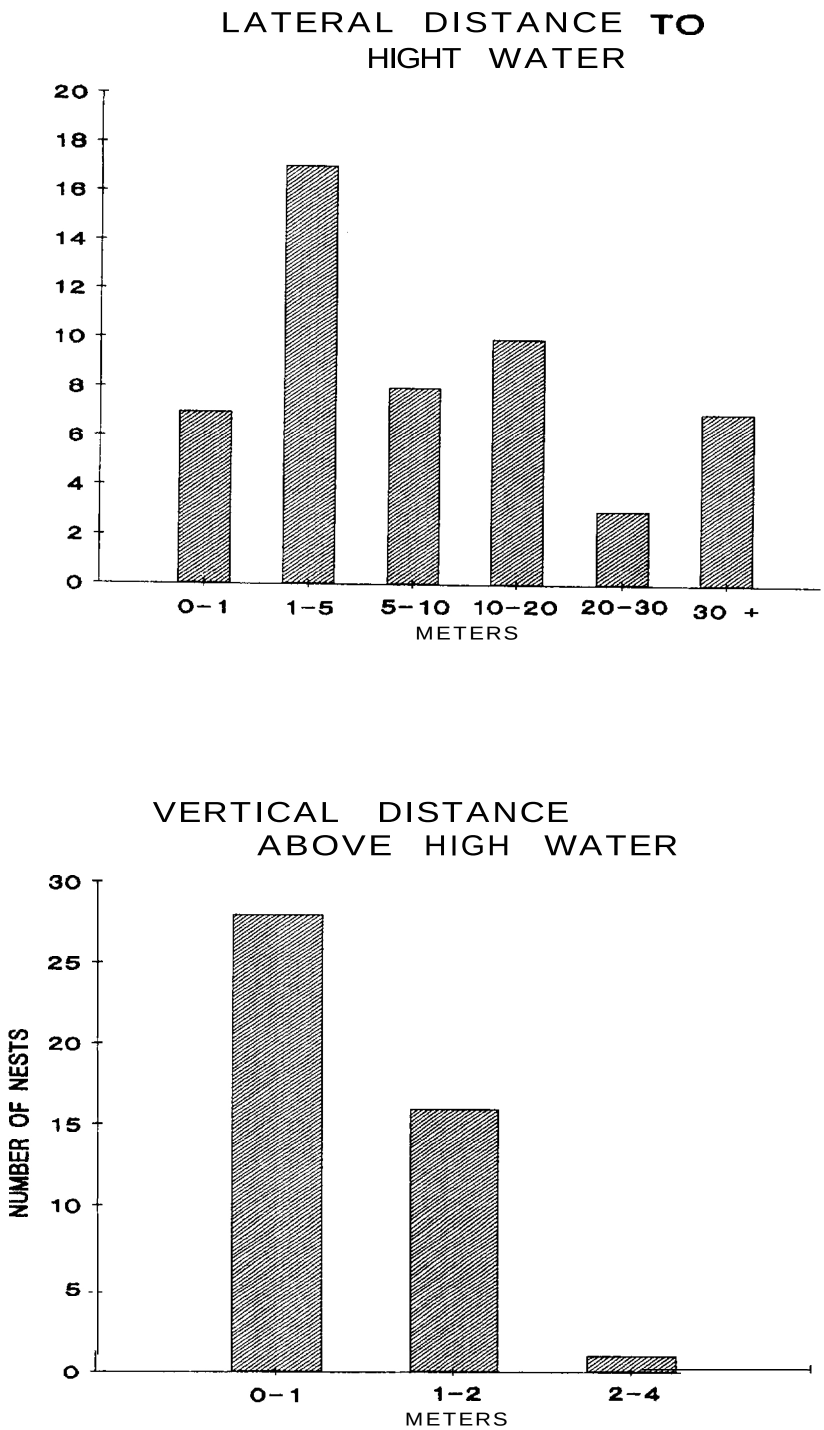


Figure 18. **Relationshipof Canada goose nest trees to the seasonal high water mark, northern Flathead Valley,** 1984-1987.

Table 18. Tree height and nest height (m) for three types of tree nests used by Canada geese, northern Flathead Valley, Montana.

	Snags		Broken-top Live		Osprey Nests[a]	
	Tree Ht	Nest Ht	Tree Ht	Nest Ht	Tree Ht	Nest Ht
Sample Size	14	14	6	7	29	29
Mean	13.70	12.40	21.70	14.29	23.25	20.42
Standard Deviation	5.94	5.34	7.69	5.65	4.38	4.12
Minimum	3.40	3.40	13.10	6.70	17.90	15.50
Maximum	23.10	20.10	30.50	21.60	36.00	33.50

[a] Includes three nests built by hawks or eagles.

BROOD STUDIES

Production

Selected aerial brood surveys from 1986 and 1987 provided brood production data (Tables 19 and 20). Earlier counts yielded few brood observations, and during later counts young could not be adequately distinguished from adults. The Flathead WPA received the greatest use by broods, as in previous years, with the largest numbers of goslings being recorded late in the b r o rearing period. Numbers typically increased at the WPA as adults with broods moved into the area to molt. We were able to document extensive brood movements through the use of radiotelemetry, including broods which traveled to the WPA from nesting areas 24 and 37 km upstream, and from Cedar Island, 19 km to the south, in 1985.

The high brood counts at the WPA for 1986 and 1987 (142, 96) were similar to the high counts in 1984 and 1985 (155, 133; Casey et al. 1985, 1986), and to the 160 reported by Barraclough (1954) during the 1953 brood-rearing season. The average annual trend count was 95 young (range 31to 173) at the WPA during the years 1975 through 1985 (USFWS, MDFWP; unpubl. data). The high count (70) along the river from Kalispell to the lake in 1987, was similar to the 11-year mean of 63 (USFWS, MDFWP; unpubl. data). However, the maximum count (170) for this reach in1986 was far above the mean. Production during 1986 was the highest we recorded during the course of the study. Production estimates were derived for each year of the study, for comparison with maximum brood count data. These estimates were developed using the known number of nests and estimated nesting success for each year, and a mean brood size of five at hatching. Maximum gosling counts were consistently lower than predicted production, averaging 67.5 percent (Table 21). The average estimated production for the three years in which our field efforts were most intensive (1985-1987) was 412 goslings. The percent of estimated production included in the annual maximum count during those three years averaged 65.3. This figure represents a combination of the efficiency of our aerial surveys and an index to gosling survival; the relative contribution of these two factors is unknown.

Survival

The only previous survival (gosling mortality) estimates which have been developed for this portion of the Flathedad Valley Canada goose population were those of Barraclough (1954), who estimated 23 percent mortality at the lake as a whole, and 8 percent mortality of goslings using the north shore, for the years 1953 and 1954. This is the highest gosling mortality reported for any western Canada goose population (Krohn and Bizeau 1980). Our analysis of census data and estimated production at hatching

Table 19. Aerial survey results, Canada goose broods, northern Flathead Valley, Montana, 1986.

Location	Total Gosling Count by Date							
	May 8	May 16	May 23	May 29	June 6	June 11	June 18	June 23
Flathead Lake WPA	25	56	96	101	142	82	101	101
Flathead River								
C. Falls - Kalispell	22	9	9	4	0	0	16	12
Kalispell-Lake[a]	83	57	52	97	149	60	112	170
McWenneger Slough	8	10	44	22	28	27	26	34
Ashley Cr.-Weaver Slough (Lower Valley)	11	2	44	55	76	55	94	56
TOTALS	149	134	245	279	395	224	349	383

a/ Includes Egan, Fennon, Church and Half Moon sloughs, Brosten's Pond (Hodgeson Lake).

Table 20. Aerial survey results, Canada goose broods, northern Flathead Valley, Montana, 1987.

Location	Total Gosling Count by Date			
	April 30	May 7	May 14	May 26
Flathead Lake WPA	72	43	96	88
Somers	5	3	0	0
Flathead River				
C. Falls - Kalispell	11	0	0	0
Kalispell - Lake[a]	42	53	70	65
McWenneger Slough	11	0	13	12
Ashley Cr. - Weaver Slough (Lower Valley)	4	10	6	42
TOTALS	145	109	185	207

a/ Includes Egan, Fennon, Church and Half Moon sloughs.

Table 21. Number of Canada goose nests, success rate, estimated gosling production and maximum gosling counts, northern Flathead Valley, Montana, 1984-1987.

Year	Nests	Percent Success	Estimated Production	Highest Aerial Gosling Count	Percent Counted
1984	44[a]	82	180	145	81
1985	108	63	340	197	58
1986	135	75	505	395	78
1987	135	58	392	207	53

[a] Several areas were not searched for nests in 1984; hence, estimated production (shown here) was low and percent counted was high.

indicated that at least 65 percent of the goslings produced in the northern Flatehad Valley survive the first month or more of the brood-rearing period. This index to early survival is crude, given the potential role that aerial survey inefficiency played in developing these figures (Table 21).

Mean brood size is apparently also a poor index to gosling survival rates, based on our 1985 calculations. We found no decrease in brood size from age classes I through VIII: nor did brood size decrease when each five-day period beginning April 25 and ending July 5 were compared, for broods observed throughout the study area (Table 22). Dropping broods of ten or more goslings from the analysis had no effect on the results, and brood sizes at the WPA also showed no decline over time (Table 22). In all cases, mean brood size varied from 3.8 to 6.3 but the mean of means was 4.8 for the entire brood-rearing period.

We witnessed five occasions where broods increased in size due to social interactions with other broods. In three cases, the brood gained one gosling (4-5, 5-6, 5-6), and in two cases the brood increased by two goslings (S-7, 6-8). This type of brood mixing makes it difficult to assess survival based on mean brood size, particularly in situations such as two we witnessed where the adopted gosling(s) had been the only ones with the adults they left. For example, collared birds MY15 and MT17, who apparently hatched a brood of five young, were joined by a lone gosling from another pair, effectively changing the mean brood size from three (two pairs, six goslings) to six (one pair with six goslings), since pairs with no young were not considered when developing these mean values. Our survey data indicated that unsuccessful pairs from elsewhere move into the study area as early as mid-May, so including these in the analysis would add a further bias to the results.

Brood-rearing Areas

Nine important brood-rearing areas were identified within the study area (Table 23, Appendix K). These areas received consistent use during the four field seasons as indicated by brood survey flights. On the main stem Flathead River above the lake, most brood use occurred on the associated oxbow sloughs, particularly Half Moon and Egan Slough. Only two areas within the main stem Flathead River were identified as key brood-rearing areas. One area encompassed a maze of islands and river channels within the main stem of the river. The second area included secluded ponds and narrow, low flow channels adjacent to the main stem.

The north shore of Flathead Lake received extensive use by broods throughout the brood-rearing period. That portion of the WPA west of the mouth of the river and east of Somers received the

Table 22. Mean brood size of CAnada geese by age class (Yocom) and Harris 1965) and by date, northern Flathead Valley, Montana, 1985.

		x Brood Size		x Brood Size (Broods of <10 goslings)	
Category	(n)	Study Area	WPA Only[a]	Study Area	WPA Only[a]
Age Class	I (57)	5.0	5.2	5.0	5.2
	II (63)	5.0	5.2	4.5	4.8
	III (60)	4.7	5.1	4.6	4.9
	IV (63)	5.1	5.1	4.7	5.0
	V (3	5.0	4.9	4.8	4.7
	VI (20)	5.0	5.0	5.0	5.0
	VII (12)	6.3	6.3	6.3	6.3
	VIII (11)	6.0		5.0	
Date					
4/25-4/30	(3)	4.0	---	4.0	---
5/01-5/05	(12)	5.3	---	5.3	---
5/06-5/10	(28)	4.6		4.6	---
5/11-5/15	(32)	5.3	---	5.0	---
5/16-5/20	(7)	4.9		3.8	---
5/21-5/25	(75)	4.9	---	4.6	---
5/26-5/30	(31)	4.8	---	4.6	---
5/31-6/04	(37)	5.2		5.0	
6/05-6/09	(49)	5.0		5.0	---
6/10-6/14	(25)	4.4		3.9	---
6/15-6/19	(50)	5.0		5.0	---
6/20-6/24	(23)	5.6		5.1	
6/25-6/29	(38)	5.8	---	5.6	---
6/30-7/04	(21)	5.4	---	5.4	---
7/05-	(1)	6.0		6.0	---
					---

[a] For broods in the WPA, mean brood size by date was not calculated.

Table23. Important brood-rearing areas used by Canada geese, northern Flathead Valley, Montana

Area	Locatioin	Cover Type Sampled
Ashley creek - Weaver Slough	Lower Valley	Herbaceous strip above creek
Braided Area	River SE of Kalispell	Herbaceous island peninsula Pasture
Brosten's Pond	Lower Valley	Pasture Wet meadow
Egan Slough	Lower river slough	Pasture Marsh Cultivated
Goose Alley East	Lower river	Pasture
Half Moon Slough	Lower river slough	Pasture
Smith Slough	Upper river slough	Herbaceous bank
McWenneger - Shaw's Slough	Upper river slough	Pasture (3 sites) Wet meadow
WPA	North shore lake	Marsh (Butomus)

most use. Broods were never observed on the north shore east of the river mouth.

Areas selected by broods provided secure feeding sites, as well as loafing sites and escape cover. Apparently, these areas are traditional as indicated by observations of radio-equipped geese returning to the same sites year after year. In many cases these areas are quite distant from the nest site (24 km or more).

Ashley Creek - Weaver Slough

This brood area complex included a portion of Ashley Creek from its mouth on the lower river upstream for approximately 5 km and the associated oxbow named Weaver Slough. Broods were observed at several sites along the creek but consistent use occurred on the creek bend directly west of the upper end of Weaver Slough. Here brood use concentrated on the dense herbaceous creek bank and a barley field nearby. Broods were often observed in the aquatic vegetation in Weaver Slough as well. Radio-equipped geese supplied documentation of this area's importance and traditional use. Two small (less than 1 m^2) populations of *Butomus umbellatus* were discovered in Weaver Slough in 1986. We did not directly observe geese using this food source at this location, however, we documented its importance elsewhere.

Braided Section - Flatehad River

This area included approximately 4 sqkm of diverse habitat formed by many channels of the main stem Flathead River southeast of Kalispell. The many islands, gravel bars and high water channels were all influenced by spring flows and Hungry Horse discharge. Broods were observed at several locations within this area but concentrated use occurred on the eastern channel and an adjacent upland pasture. During periods of high flows, several gravel bars used for loafing were inundated. One herbaceous area consistently used by broods for foraging and loafing was flooded during high flows. The pasture site was well above the high water but was susceptible to bank erosion.

Brosten's Pond

Brosten's Pond (also known as Hodgeson Lake) received consistent use by broods during 1984, 1986, and 1987. This natural pond is located in the lower valley area approximately 100 m from the river. A high bank separated the pond from water level fluctuations on the river. Broods were frequently observed grazing in the pasture bank between the river and the pond. The dense herbaceous area on the outside edge of the cattails also received extensive use. The pond itself was used for security. Nesting success at this pond was generally poor due to predation but the numbers of broods using the area indicate movement to this site for brood-rearing.

Egan Slough

Egan Slough is a large oxbow located north of the lower river. Because landowners regulate the water levels with a culvert, the slough is not directly influenced by Kerr Dam. The slough has not changed significantly since the early 1930's based on comparisons to early photos, and supports diverse aquatic vegetation and emergent development. Broods were frequently observed on the west arm of the slough on grazed pasture peninsula and a cultivated field to the south.

Goose

A pasture and several small ponds adjacent to the lower river approximately 20 km north of the lake received brood use in 1985, 1986, and 1987. Goslings which used this area probably hatched from the several tree nests located nearby. Because of its proximity to the river, the ponds were influenced by water levels on the river. During full pool, the open water area in these ponds increased in size.

Half Moon Slough

Brood use at Half Moon Slough was concentrated on an adjacent pasture near the upper tip of the slough. Although small numbers of broods used this area, use was consistent throughout the study period. Observations were numerous because of use by radio-equipped geese. The slough was directly influenced by water levels on the river. Early in the brood-rearing period mudflats separated the open water from the pasture grazing site. However, observations indicated the geese readily crossed the mudflat area during periods of low water.

McWenneger and Shaw Sloughs

This slough complex is located approximately 2 km east of the main stem Flathead River immediately northeast of Kalispell. Both sloughs are old oxbows and are removed from water level influences of the river. Most observations of broods on McWenneger Slough occurred on a pasture and a wet meadow site adjacent to a pond at the northern end of the slough. A pasture area on a peninsula into the main slough also received extensive use.

Shaw Slough includes the channel that connects McWenneger Slough and the main stem Flateahd River. Broods were observed occupying a pasture between the slough and a pond located north of the slough.

Smith Slough

This brood area was further upriver than any other site used consistently by broods. Observations of broods were documented during each of the four field seasons. The area included two oxbow ponds and a high water channel east of the main stem. Broods were observed in medium herbaceous sites adjacent to the ponds and on pastures above the high water channel. Most of the area was privately owned. Dense vegetation and limited public access provided security for the broods. Because of its location distant from the main stem Flathead River, this area was not influenced by water level fluctuations due to Hungry Horse Dam.

Flathead Lake - WPA

The north shore of Flathead Lake west of the river delta (WPA) received the most consistent use as well as the highest count of broods during the entire study period. Observations compiled from activity budget surveys indicated extensive use of bays outside the zone of emergent cattail vegetation. All sites were nearly identical in species composition and density. The nearly monotypic communities were dominated by *Butomus umbellatus*.

During the early brood-rearing period in 1986, we measured the distances across the mudflats from the lake to stands of *Butomus*. On April 24 with the lake level at 2,885.5 ft broods traveled 217 m from the water to *Butomus* stands near Tower 1. Two other preferred feeding areas were even farther away. The distance from the lake to the bay between Tower 2 and the eagle nest B02 was 310 m. The heavily used bay at Tower 3 was over 660 m from the lake edge. During time budget surveys, we recorded many observations of pairs with broods traveling across the mudflats to reach feeding sites or the security of the open water.

Habitat Measurements in Brood-rearing Areas

Within these nine areas, specific sites were sampled to describe physical and vegetation characteristics of important feeding and resting areas. Seventeen sites were sampled to describe key areas common to the brood-rearing areas. Data from all of the sampled sites were combined to describe certain habitat parameters (Table 24). The 17 sites sampled were an average 0.7 m above the high water and 7.2 m from the high water. These figures support the observation that geese with broods select areas adjacent to open water, however, the figures do not reflect any potential influence of flooding or dewatering. Individual sites will be discussed to describe those potential impacts.

Table 24. Habitat characteristics of 17 sites within Canada goose brood-rearing areas, northern Flathead Valley, Montana.

	Distance Other Cover Type (m)	Distance Other Landform (m)	Height Above High Water (m)	Distance High Water (m)	Distance Existing Water (m)
Mean	11.79	13.49	0.70	7.20	7.76
Standard Deviation	12.18	13.22	0.48	6.44	5.96
Minimum	1.00	1.50	0.10	0.10	0.10
Maximum	52.00	52.00	1.50	20.00	20.00

The 17 sites sampled several cover types including pastures grazed by livestock, natural herbaceous areas, marsh, and cultivated sites. Data from eight sites were combined to describe pastures used by brood-rearing geese. The pasture sites were less than 1.0 m above the high water and less than 13 m from the high water (Table 25). However, none of the pasture sites were directly influenced by water level fluctuations. Five of the sites sampled were associated with ponds or sloughs with fairly stable water levels and at some distance from the main stem of the river. The one pasture adjacent to a channel of the river (braided section) was well above the high water but would be susceptible to erosion if the main river flows were channeled in its direction. Two pasture sites were associated with off-river sloughs, but because of their location were not affected by water levels.

Vegetation cover of pasture sites was dominated by dense grass, averaging 72 percent and forbs, averaging 25 percent (Table 26). Species composition, frequency, and percent cover for these areas are listed in Appendix L. Pasture sites were characterized by 35 grass and forb species and several unidentified Carex and Juncus species. Agrostis alba (65 percent), Agropyron repens (27 percent), and Poa pratensis (45 percent) provided the most cover. Twenty-five species of forbs were recorded on pasture sites. Several species occurred with high frequency but with limited cover. These included Medicago lupulina, Taraxacum officinale, Plantago major, Trifolium repens, and Equisetum spp.

Descriptions of natural herbaceous areas used by brood-rearing geese were developed from analysis of five sites. These sites included wet meadows adjacent to ponds, medium herbaceous areas along streams or sioughs, and one site on a river island. Natural herbaceous sites were generally closer to high water than pasture sites. On average, these areas were less than 3 m from the HWM and less than 0.5 m above the HWM (Table 27). Although these sites were relatively close to high water only one site was directly influenced by water levels. This site was located on a river island bar in the braided section and was inundated by high flows.

Natural herbaceous sites were similar to pasture sites, being dominated by grasses (72 percent) and forbs (21 percent, Table 28). Species diversity was generally greater (47t spp.) in the natural herbaceous sites than pasture areas (35 spp.). Several grass species were common and contributed at least 18 percent of the cover. These included Agrostis alba (27 percent), Agropyron repens (18 percent), Phalaris arundinacea (33 percent), Poa pratensis (33 percent), Carex spp. (25 percent), and Juncus spp. (46 percent). Forbs were dominated by Equisetum spp. (22 percent) and Cirsium spp. (39 percent).

The other cover types received limited sampling because of their homogeneity. Two marsh sites were sampled. The site sampled at Egan Slough was considered representative of aquatic

Table 25. Habitat characteristics of pasture brocd-rearing areas used by Canada geese, northern Flathead Valley, Montana.

	Height Above High Water (m)	Distance to High Water (m)	Height Above Ekisting Water (m)	Distance to Ekisting Water (m)	Distance Other (m)	Distance Other Landform (m)
SampleSize	8	8	8	8	8	8
Mean	0.92	12.45	0.92	12.45	Il.75	14.33
Standard Deviaticn	0.43	4.76	0.43	4.76	2.99	9.12
Minimum	0.22	9.00	0.22	9.00	9.00	9.00
Maximum	1.50	20.00	1.50	20.00	17.80	35.00

Table 26. Vegetation cover (percent) by classes for pasture brood-rearing areas used by Canada geese, northern Flathead Valley, Montana.

	Graminoid	Forb	Shrub	Tree	Bare Ground
Sample Size	8	8	8	8	8
Mean	72.38	25.13	3.00	0.75	0.88
Standard Deviation	21.82	25.31	5.01	2.12	2.10
Minimum	45.00	0.00	0.00	0.00	0.00
Maximum	91.00	56.00	12.00	6.00	6.00

Table 27. Habitat characteristics of natural herbaceous areas used for brood-rearing by Canada geese, northern Flathead Valley Montana.

	Height Above High Water (m)	Distance to High Water (m)	Height Above Existing Water (m)	Distance to Existing Water (m)	Distance Other Cover Type (m)	Distance Other Landform (m)
Sample Size	5	5	5	5	5	5
Mean	0.49	2.72	0.68	4.62	12.62	14.42
Standard Deviation	0.46	4.15	0.42	3.40	22.10	21.43
Minimum	0.10	0.10	0.20	1.50	1.00	1.50
Maximum	0.99	10.00	0.99	10.00	52.00	52.00

Table 28. Vegetation cover (percent) by classes for natural herbaceous areas used for brood-rearing by Canada geese, northern Flathead Valley, Montana.

	Graminoid	Forb	Shrub	Bare Ground
Sample Size	5	5	5	5
Mean	72.20	20.80	3.80	4.40
Standard Deviation	19.83	17.98	6.94	4.28
Minimum	47.00	2.00	0.00	0.00
Maximum	95.00	44.00	16.00	9.00

habitats used by broods at Weaver Slough, McWenneger Slough, Shaw Slough, and Brosten's Pond. *Typha latifolia* (45 percent) and *Scirpus acutus* (52 percent) dominated the marsh sites. The open water areas adjacent to the cattails and bulrush contained diverse aquatic species including *Myriophyllum* spp., *Ceratophyllum demersum*, *Lemna* spp., and *Elodea* spp.

The second marsh site sampled was considered representative of preferred feeding areas used by geese on the WPA. The site was dominated (85 percent) by *Butomus*, and was typical of the area between the cattail marsh and open water. Only one other species, *Polygonum amphibium*, was found when the sample was taken at full pool. Approximately 121 acres of *Butomus* stands occur on the north shore of Flathead Lake and the stands appear to be increasing in size (J. Jourdonnais, pers. comm.). Smaller populations are spreading along the south shore of Flathead Lake (S. Gregory, pers. comm.).

Two cultivated areas were consistently used by broods. The first site on Egan Slough included a weedy site used for loafing and an adjacent barley field used for feeding. The barley field was 24 m from the open water. Only a limited area (<600 m^2) of the field was grazed by geese.

The second cultivated area was located adjacent to Ashley Creek. Several broods including the radio-equipped pair, MY15 and MY17 grazed the barley field approximately 5 m away. An area 20.5 m by 17.0 m was grazed by geese.

Brood Activity Budgets

Goslings spent nearly twice as much time feeding as adults (48.5 vs. 25.8 percent), and far less time alert than adults (1.3 vs. 25.3 percent) (Table 29). This was expected since adults typically stood watch while goslings fed. Much of the time spent by both goslings and adults in locomotion was probably in response to minor disturbance: only obvious disturbance responses were classified as such, leading to the low total for that category (0.1 percent goslings and 0.2 percent for adults).

Grazing comprised 76.8 percent of all gosling feeding activity throughout the brood-rearing period. Most grazing was done in marsh (47.5 percent) and short herbaceous (21.3 percent) cover types, although most of the observations listed as pecking, (19.8 percent of all feeding) which occurred primarily (96.3 percent) on WPA mudflats, almost certainly represented grazing of very small shoots. A total of 87.7 percent of all gosling feeding activity took place in short herbaceous, cultivated (pasture), marsh, and mudflat cover types.

Gosling activities were analyzed for surveys conducted at Flathead WPA, to assess behavioral changes in response to rising

Table 29. Percent of time spent in various activities and cover types, Canada goose adults and goslings, northern Flathead Valley, 1985-1986.

Category	Mean Percent of Time Per Category[a]	
	Goslings	Adults
Activities:		
Grazing	37.2	20.7
Pecking	9.6	4.1
Other Feedings b/	1.7	1.0
Resting	ii.9	7.5
Walking	12.4	13.3
Swimming	11.1	11.0
Comfort Movements[c]	9.1	11.1
Social Interaction	0.2	1.8
Brooding	1.6	1.5
Alert	1.3	25.8
Disturbed	0.2	0.2
Cover Types:		
Deciduous Forest	0.3	0.3
Tall Herbaceous	0.2	0.2
Short Herbaceous	12.6	12.3
Medium Herbaceous	2.7	3.0
Cultivated[d]	10.9	10.9
Marsh	34.5	35.4
Aquatic Vegetation	6.1	5.9
Open Water	8.2	8.3
Unvegetated Mud Flat	20.7	21.0
Bare Dirt	0.3	0.3

a/ From 312 half-hour time budget surveys, April-July, 1985-1986.
b/ Includes tipping, hawking, gleaning.
c/ Preening, stretching, drinking.
d/ Primarily grazed pasture.

lake levels during the brood-rearing period (Figure 19). Goslings spent more time traveling at lower lake levels (<2,889.5 ft) than at higher lake levels. Most of this time is spent walking on exposed mudflats. As the brood-rearing season progresses, the geese tend to become more sedentary, probably due to the increase in forage and cover available as the lake inundates emergent vegetation stands. Geese are also more easily disturbed during the period when mudflats are more extensive, and therefore travel more in response. Feeding activities were primarily pecking at lowest lake levels, with a shift to grazing as the lake level rose and the ratio of vegetated to non-vegetated habitat available to the geese increased. Percent of time spent feeding increased from 48.0 at lake levels between 2,884-S and 2,887.0 ft. to 69.2 at 2.889.6 to 2,891.6 ft, and dropped again to 45.8 percent at highest lake levels. This trend is a result of the decreasing disturbance as lake levels rise, and the drop late in the season may represent a decrease in the caloric intake needed by broods as they approach adult size. This is supported by the increase in time spent resting by goslings as the season progressed.

Because data were collected from single goslings and adults within the same brood, time spent in each different cover type goslings and adults were highly correlated (r = 0.999). Differences were recorded primarily when broods were in ecotones.

Mudflats without any visible vegetation were classified as unvegetated, even when geese were apparently feeding on very small shoots, leading to high totals for that cover type (Table 29). The cover types we used reflect phenology, and goslings feeding in the same area throughout the brood-rearing period were therefore sometimes coded as feeding in unvegetated, then short herbaceous, then medium herbaceous cover types as the season progressed. Rising water levels also led to changes in cover type coding from mudflat to intertidal, to marsh in some areas. These changes are reflected in the changes in use of cover types we recorded for varying lake levels (Figure 20). The vast majority of brood observations collected at Flathead WPA were in areas dominated by Butomus, which tolerates a wide variety of water depths (A. Schuyler, Botanist, Academy Natural Sciences, Philadelphia, pers. commun.).

As we first noted in 1984 (Casey et al.1985). broods at the WPA spend a great deal of time in exposed habitats. Goslings spent much (47.3 percent) of their time in unvegetated or short herbaceous cover types. At lower lake levels, broods spent 77.8 - 85.2 percent of their time in these types (Figure 20). It is still unclear if this trend of using the exposed mudflats affects survival of goslings. We witnessed several instances where predators came close enough to broods to influence their behavior, but witnessed no actual predation during our brood surveys. On several occasions, adults with broods showed no reaction to nearby avian predators. These included a northern harrier (Circus cyaneus) that flew within 5 m of a brood, ospreys perched as close

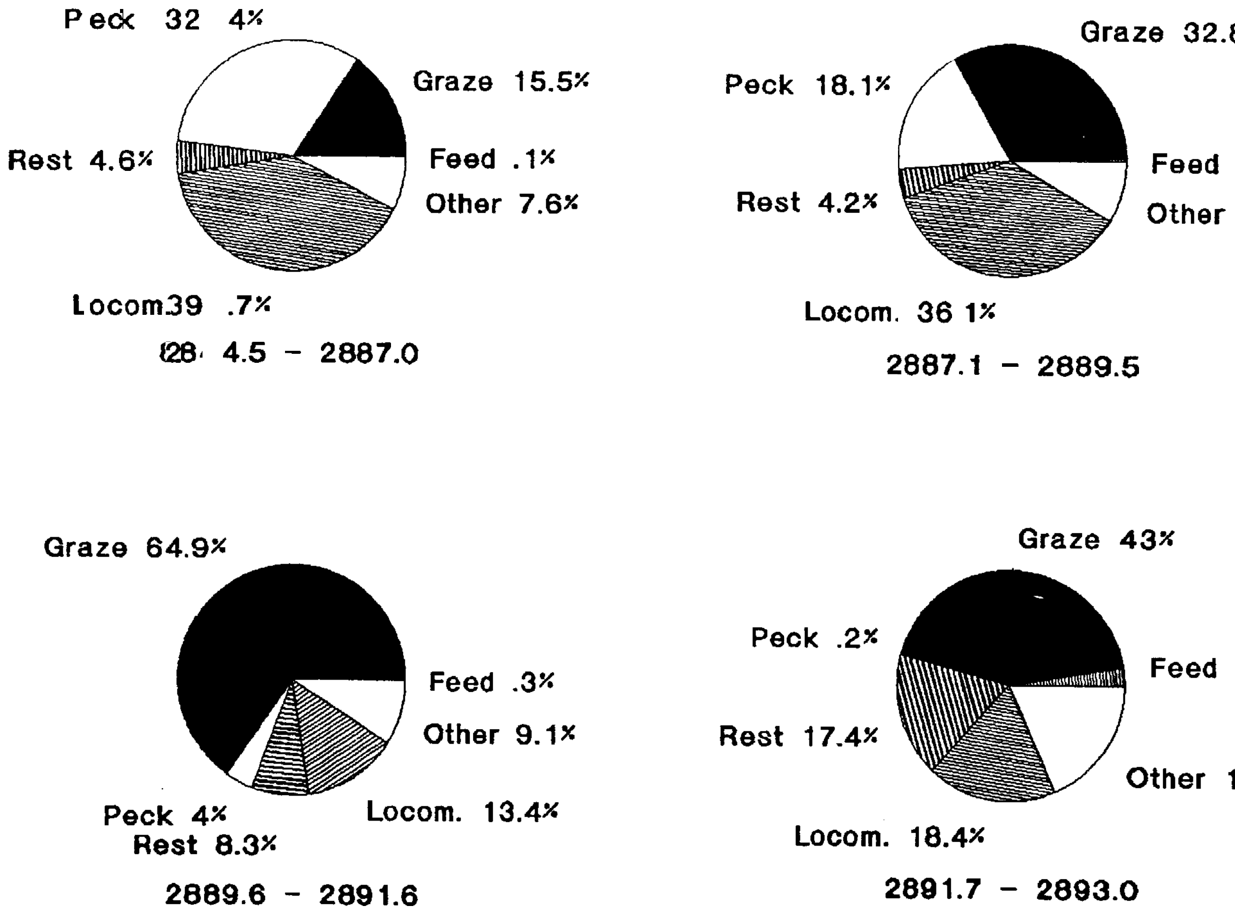


Figure 19. Gosling activity versus Flathead Lake level, Flathead WPA, 1985-1986.

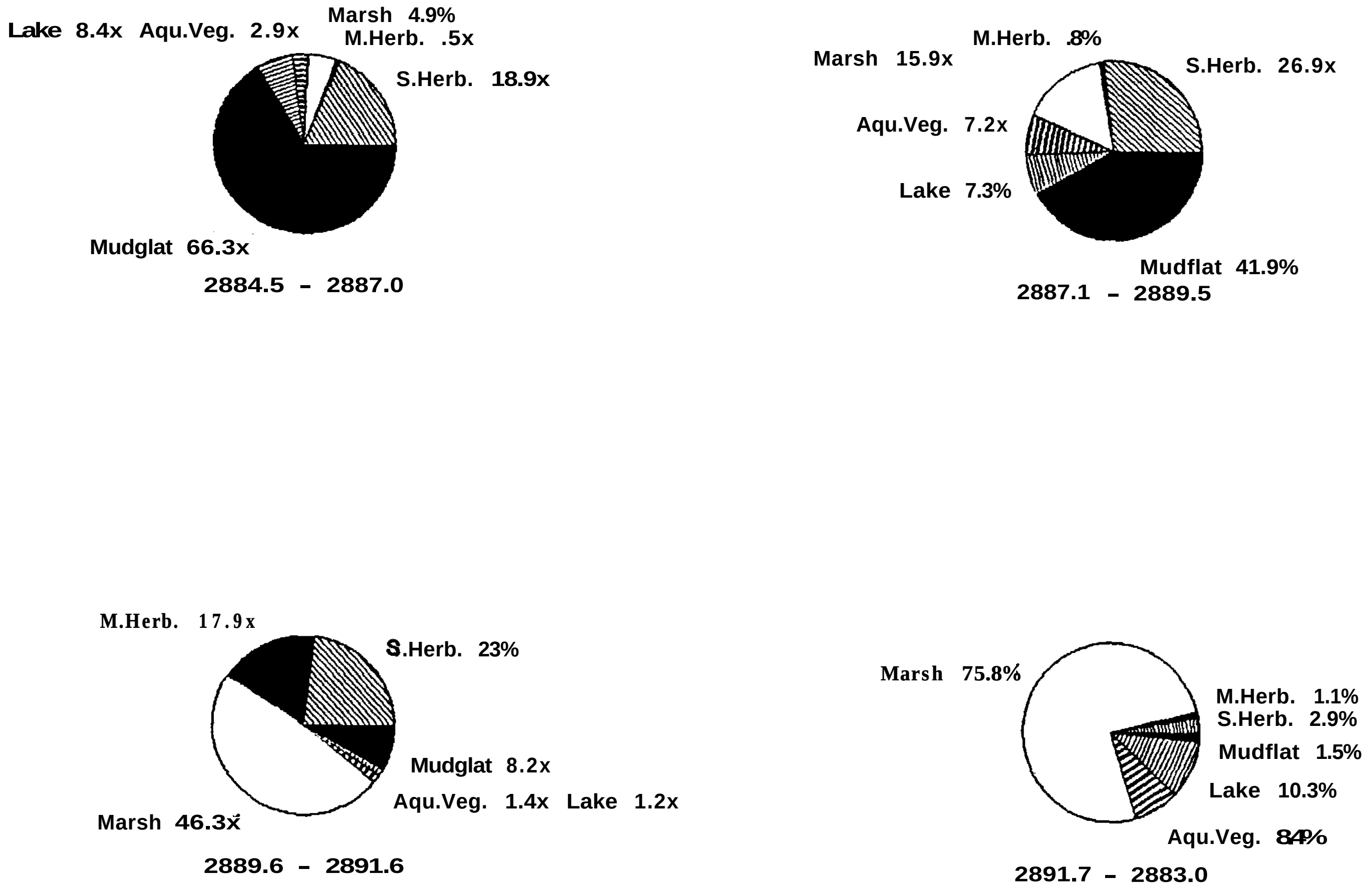


Figure 20. Gosling use of cover types versus Flathead Lake level, Flathead WA, 19841986.

as 30 m to feeding broods, and bald eagles perched within 15 m of swimming broods. Reactions to avian predators ranged from swimming out into the lake to avoid a perched eagle, to alert adults "herding" goslings together as they swam past an eagle, to an instance where adults actually charged one of three nearby American crows which had not harassed the goslings. We witnessed one incidence of a red fox (Vulpes vulpes) approaching a large flock of geese at the WPA, **but did not** see the outcome. No other incidents with mammalian predators were witnessed, though adults showed a mildly disturbed (alert) reaction even to a beaver (Castor canadensis) swimming past a feeding brood.

We witnessed geese using stumps, logs, depressions in the mud flats, and emergent (cattail, flowering rush) stands as escape or resting cover at the WPA. Broods in the mudflats fled either to upland/mudflat ecotones or onto the open water of the lake, depending on the location of the perceived threat.

HABITAT

Habitat Distribution

Cover types found on the upper river were mapped to describe the distribution of habitats available for Canada geese. We sampled the vegetation components of eight cover types to provide quantitative description of representative sites (Appendices M and N). Cover types found on the lower river and the north shore were mapped as part of another study on erosional processes (Hauer et al. in prep). Data from this research provided cover type information for these two areas.

Upper River

Approximately 3,175 acres of riparian habitat were cover typed with aerial photos to describe the distribution of habitats along the river above Kalispell (Table 30). Figure 21 summarizes the cover types available along this reach, combining similar categories.

Most of the upper river riparian zone was dominated by forests (62 percent). Deciduous forests, both mature and intermediate (immature) stands, dominated the forest communities (60 percent). Most of these stands were found on the lower third of this river reach, particularly in the braided section immediately south of Kalispell. The younger, intermediate stands of cottonwoods were typical of islands in the middle of this river reach. Nearly all the coniferous forests and the mixed forests were found on the steep banks near Columbia Falls.

Dense shrub (12 percent) and herbaceous (12 percent) areas comprised the next highest percentages of available cover types.

Table 30. Cover types distribution on the upper main stem Flathead River between the South Fork and Foy's Bend, northern Flathead Valley, Montana.

COVER TYPE	ACRES	COVER TYPE	ACRES
Coniferous forest	175	Sparse shrub - mixed	29
Deciduous forest - mature stands	942	Sparse shrub - cottonwood/willow	227
Deciduous forest - immature stands	247	SUBTOTAL	256
Mixed forest -	605	Natural herbaceous	83
SUBTOTAL	1,969	Pasture	172
Dense shrub - mixed	191	Cultivated	132
Dense shrub - cottonwood/willow	196	SUBTOTAL	387
SUBTOTAL	387	Developed/disturbed	107
		Other	69
		SUBTOTAL	176

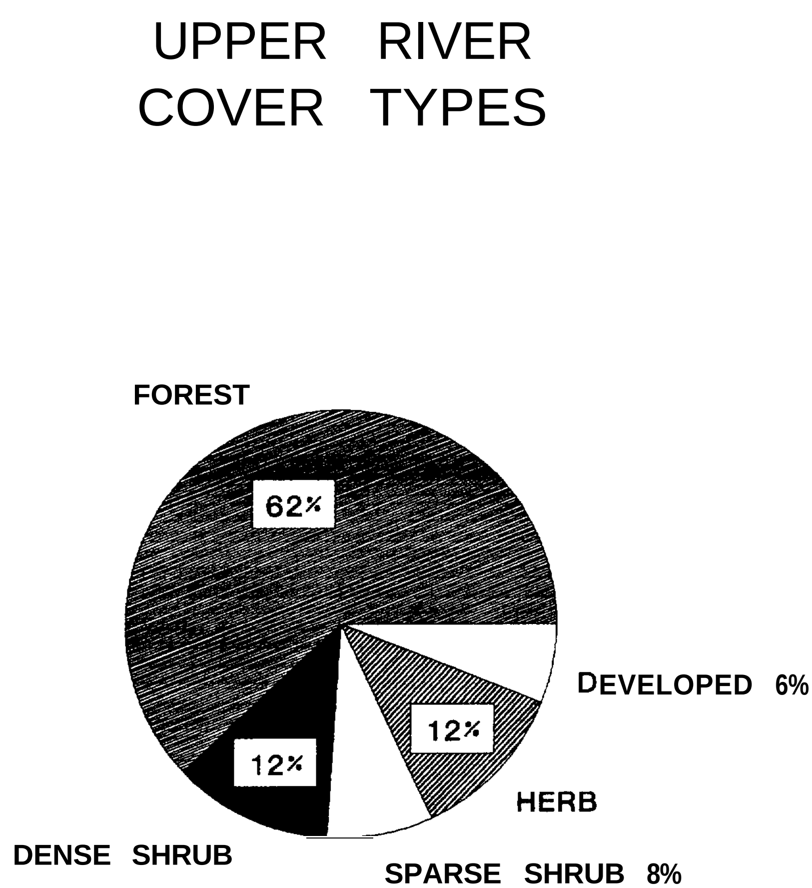


Figure 21. Cover type distributin, upper Flathead River from the South Fork to Foy's Bend, northern Flathead Valley, Montana.

The dense shrub types were found throughout this river reach. Nearly equal amounts of mixed shrub (191 acres) and cottonwood-willow regeneration stands (196 acres) were present in the riparian zone.

Herbaceous areas had only a limited distribution in the riparian zone. Most (79 percent) of these herbaceous areas were either pastures or cultivated sites.

Lower River

Habitat maps, developed from 1979 aerial photos (Hauer et al. in prep), were used to determine the distribution of cover types on the river reach below Kalispell (Table 31). Most of the lower river riparian zone was dominated by agricultural areas (71 percent). Deciduous forests comprised only 17 percent of the riparian zone and generally existed as narrow strips immediately adjacent to the river.

North Shore

Agricultural (20 percent), herbaceous (24 percent), and marsh (17 percent) areas comprised the largest percentages of north shore cover types (Table 32). Very limited amounts of forest areas were available. *Butomus* comprised only 9 percent of the total cover types. The marsh and shoreline debris (6 percent) cover types occupied a zone between the *Butomus* and herbaceous/agricultural areas. The 33 acres of ponds included several man-made ponds located near the central WPA.

Habitat Loss Estimates

North Shore

The habitat destruction occurring on the north shore is a result of increased erosion when the lake elevation remains high during the storm seasons. Woessner et al. (1985) provided a clear description of wave dynamics and erosional processes occurring along the north shore of Flathead Lake. The shoreline retreat was first documented by Moore et al. (1982). who reported that more than 8 sq km (approximately 2,000 acres) of sediment was removed from the delta plain between 1937 and 1981. Sediment was eroded to a depth of 1.5 m, exposing roots of trees and completely removing the other vegetation.

The area near the Somers side has apparently approached equilibrium (Hauer et al. in prep.). The area immediately west of the river mouth continues to erode at a rate of approximately 13 m per year, and the Bigfork side is also rapidly retreating.

Table 31. Cover type distribution found on the main stem Flathead River from Foy's Bend to Flathead Lake. (Adapted from Hauer et al. in prep.)

Cover Type	Acres	Percent
Deciduous forest	1,485	17
Coniferous forest	3	tr[a]
Mixed forest	273	3
Herbaceous	89	1
Marsh	328	4
Ponds	85	1
Agriculture	6,208	71
Developed	299	3
TOTALS	8,770	100

a/ tr = trace (X0.5)

Table 32. Cover type distribution north shore Flathead Lake. (Adapted from Hauer et al. in prep.)

Cover Type	Acres	Percent
Shoreline debris	95	6
Butomus	151	9
Marsh	298	17
Ponds	33	2
Coniferous forest	8	1
Deciduous forest	116	7
Mixed forest	17	1
Herbaceous	405	24
Agriculture	333	20
Developed	224	13
TOTALS	1,680	100

We documented a dramatic change in the delta islands through direct measurements and photo-documentation starting in 1985. Prior to the lake reaching full pool, the remnant cattail island was 47.4 m long and about 4111~1^2 in area. The wooded island was approximately 20 m long and 90 m^2 (+10 m2) in area. By November, the cattail island had been completely eroded away and the wooded islandhad eroded down to an estimated 30-40 m2 (T.O'Neil, pers. commun.). As of May 1987, less than 2 m2 of island remained, and this was lost completely by mid July 1987.

A review of historical documents provided general descriptions of the north shore area prior to construction of Kerr Dam. Shoreline vegetation in the delta was described by Norton (1919) as dense shrub stands of serviceberry (Amelanchier sp.), chokecherry (Prunus sp.), rose, ninebark (Physocarpus sp.), willow and extensive stands of cottonwood, .aspen, and birch. Swamps and meadows were also noted along the north shore.

Jones (ca. 1910) reported a "great delta, miles in extent, covered with a forest of cottonwoods interspersed with evergreens, and "one giant species of Populus not found elsewhere." Extensive aquatic beds were reported in the lake at the mouth of Flathead River, with species composition similar to the large "swamp" at the south end of the lake (Polson Bay).

Analysis of aerial photographs documented the loss of 1,859 acres of habitat along the north shore of Flathead Lake (Figure 22). This loss represents the amount of terrestrial vegetated habitat that is now the mudflat region between the lake and the cattail\bulrush marsh when the lake is below full pool. Most (63 percent) of the habitat lost included herbaceous habitat types (Table 33). Thirty-one percent of the habitat lost included forested areas.

In addition to the acres actually lost due to inundation or erosion, it is apparent from the photographs that changes occurred in the adjacent remaining habitat. These changes were not quantitatively described because of the difficulty in assessing whether these changes were due to water levels, natural succession, or mechanical manipulation. However, two plant communities in particular should be discussed. The cattail\bulrush community between the earthen dike and the open water\mudflat area represents an example of a change in terrestrial vegetation rather than a direct loss. Approximately 205 acres of marsh now exists where herbaceous meadows were present prior to construction of Kerr Dam. According to estimates by Hauer et al. (in prep.), 121 acres of Butomus now occupy some of the mudflat areas.

Loss of stumps

Only ten of the 15 delta stumps used for nesting in 1985 were still available for use in 1986. Two stumps were lost entirely to

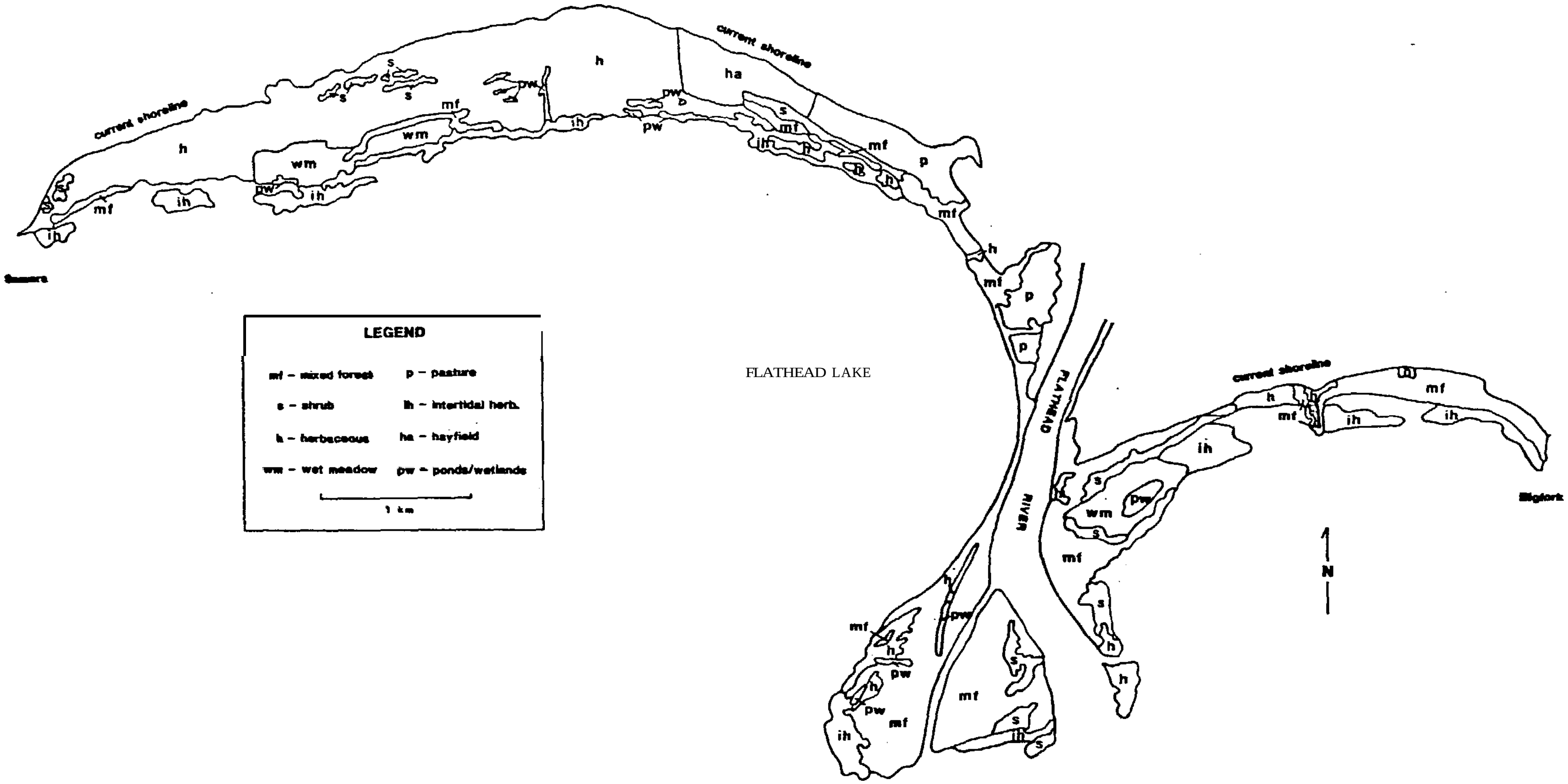


Figure 22. Habitat losses, north shore Of Flathead lake, 1937-1987.

Table 33. Habitat losses on the north shore of Flathead Lake, Montana, 1937-1985, as determined from aerial photographs.

Habitat Type	No. Acres Inundated/Eroded
Forest[a]	571
Dense shrub	76
Herbaceous	
Grass/forb, sparse shrub	671
Wet meadow	114
Shoreline herbaceous	190
Pasture	118
Hayfield	86
Wetlands (ponds/marsh) (n-12)	33
TOTAL	1,859

[a] Includes coniferous, deciduous, and mixed coniferous-deciduous stands.

erosion, and three were eroded beyond suitability. Three of the ten were lost during the following year (full pool 1986), and one was eroded beyond suitability. Stumps marked in 1986 fared even worse. Six of seven newly-used stumps were lost to erosion at full pool. These losses amount to an annual loss rate of 33 to 89 percent of stumps used for nesting.

A minimum of 816 stumps were present on the delta during May 1986. This count was conservative, because water depth on the delta approached 1 m during the period, and we did not count stumps completely under water. A total of 712 stumps remained standing as of January 1987, meaning that a minimum of 104 (12.7 percent) stumps were lost to erosion during full pool 1986.

The Lower Flathead River

Habitat losses have also occurred on the lower river section below the braided area southeast of Kalispell. The extended period of high water levels because of operation of Kerr Dam has resulted in some vegetated areas being lost. Over time, the terrestrial vegetation has died off in areas where seasonal flooding has occurred. During low pool mudflat areas exist where riparianvegetation existedpriorto Kerr Dam. Severalmudflat areas, particularly in Swim Creek, Fennon Slough, Church Slough, and Mill Creek, contained remnant stumps or roots of large trees, similar to the delta conditions.

We determined that a minimum of 335 acres of terrestrial habitat was lost on the lower Flathead River based on maps developed by Hauer et al. (in prep). We subtracted out the amount of gravel bar/beach existing in 1937 (110 acres) because mudflats have replaced this habitat. Thus a net loss of 235 acres of terrestrial habitat has been converted to open water or mudflat.

Bissell (1987) further refined the loss estimates based on comparisons between the 1937 photos and some 1986 aerial photos of selected lower river areas. These losses included162 acres of herbaceous habitat, 8 acres of agricultural land, 34 acres of shrubland and 135 acres of deciduous forest, for atotalloss of 339 acres on this river reach. Sixty-six acres of emergents (cattails) replaced some of this terrestrial habitat loss for a net loss of 273 acres. Using the two methods described, therefore, a loss of 235-273 acres has occurred along the river above Flathead Lake.

WATER LEVEL FLUCTUATIONS

Flathead Lake - Kerr Dam

During each year of the study, minimum water levels at Flathead Lake coincided at least in part with the Canada Goose nesting season (Figure 7). Minimum lake elevations as measured at Kerr Dam ranged from 2,883.5 ft in 1985 and 1987, to 2,883.8 in 1984, to 2,884.7 in 1986. The duration of time that the lake was within 0.5 ft of minimum pool ranged from 31 days in 1985 (March 5 - April 14), to an extreme of 61 days in 1987 (February 15 - April 16). In 1984, the lake was within 0.5 ft of minimum pool for 35 days (March 17 - April 20), and for **37** days in 1986 (February 25 - April 2).

Flathead River - Hungry Horse Dam

The seasonal hydrograph for the Flathead River at Columbia Falls varied dramatically on an annual basis during the four years of this study (Figure 4). During two of the four years (1984 and 1986), the period March - June was characterized as having several peak flow periods corresponding to releases from Hungry Horse Dam. These peaks were generally in the range of 14,000 to 28,000 cfs in 1984, with releases from the dam contributing over 70 percent of the flows for five peaks late March - mid April, and 30 - 60 percent of eight peaks in late April and May. A similar pattern was evident for 1986, when ten peaks of 15,000 - 35,000 cfs occurred from mid March through late May (Figure 4). South Fork flows comprised more than 50 percent of the flow for five of those periods, and 30 - 50 percent for the other five peak flow periods.

Flathead River hydrographs for 1985 and 1987 were both characterized by early peak flows stimulated by runoff, with releases for the dam contributing very little of the flow at Columbia Falls (Figure 4). Peak flows of over 30,000 cfs were experienced before May 1 during each of these years. Releases from the dam comprised more than 50 percent of the flow at Columbia Falls for only one peak of less than 10,000 cfs each year. During these two spring periods, operation of Hungry Horse Dam as a flood control tool prevented lessened early peak flows due to runoff.

In light of the flow patterns we noted during1984-1987, we analyzed historic flow data to determine the past role that Hungry Horse Dam has played in determining the flows at Columbia Falls during the breeding season for geese. When calculating the percent contribution of the South Fork to flows at Columbia Falls, we took a conservative approach. In those cases where the reported daily mean for the South Fork was less than the expected flow based on the combined North and Middle forks, then the latter was used (i.e., main stem minus the combined North and Middle forks). Because the available database included only mean flows, we needed to select a value which represented that flow at which some nests might be at risk. The average mean flow on those days during 1984-1987 for which peak flows exceeded 30,000 cfs was 27,350 cfs, and the lowest recorded mean flow was 23,700 (peak = **31,500).** We selected 25,000 cfs as an appropriate (conservative) mean flow indicative of a potential threat to ground-nesting geese.

Flows from the South Fork have contributed 27 percent of the daily flows at Columbia Falls, on the average, for the period March 15 - June 15, each year since 1950. There was little difference between this percentage for the four years immediately preceding the closing of the dam (1950-1953, 28 percent), and for those years since the dam was shut (1954-1986, 27 percent). The daily contribution of the South Fork (Hungry Horse flows) has been different for the period March 15 - April 30 in those years that the dam has been in operation, an average of 44 percent vs. 32 percent for the years 1950 - 1953. Mean daily flows for the nesting period (March12 - May 31) for the years 1954 - 1986 are presented in Figure 23.

Mean flows at Columbia Falls have been greater than 25,000 cfs on 874 days since 1950 (March 15 - June 15 only). A total of 748 of these days occurred since the dam has been in operation. The percentage of high flow days during this three-month period dropped from 45 percent for the years 1950 - 1953, to just 24 percent for all subsequent years. This indicates that the dam is serving a flood control function, particularly in late May and early June when runoff usually peaks. Indeed, only 141 of the 748 days with flows above 25,000 cfs fell during the period March 15 - May 15, when most nests would be at risk. On 50 of these 141 days, flows from the South Fork contributed more (mean = 37 percent) than the seasonal mean of 27 percent of the flow at Columbia Falls. On 68 of the 141 days, running the dam at base load (approximately 165 cfs) would have prevented the flow at Columbia Falls from reaching 25,000 cfs. The mean flow for the South Fork on those days was 8,865 cfs. These data indicate that in certain years, releases from the dam may very well have put downstream nests at risk of flooding, and could have'been adjusted downward to lessen that risk.

OTHER WILDLIFE SPECIES

Observations for species other than Canada geese were not analyzed in detail for inclusion in this report. We did, however, collect data describing the effects of water level fluctuations on the status of other species in our study area.

During our elevated nest inventory and subsequent status checks of tree nests, ve vere able to document four active bald eagle nests in the study. One of these was a newly discovered nest in a territory which had been occupied in previous years (R. Magaddino, biologist, USFWS, pers. commun.). Data from each of these sites were supplied to the Montana Bald Eagle Working Group for their annual statewide inventory of eagle nests. These data and osprey nesting data were also coordinated with an ongoing study of these species funded by the MPC; data on water level

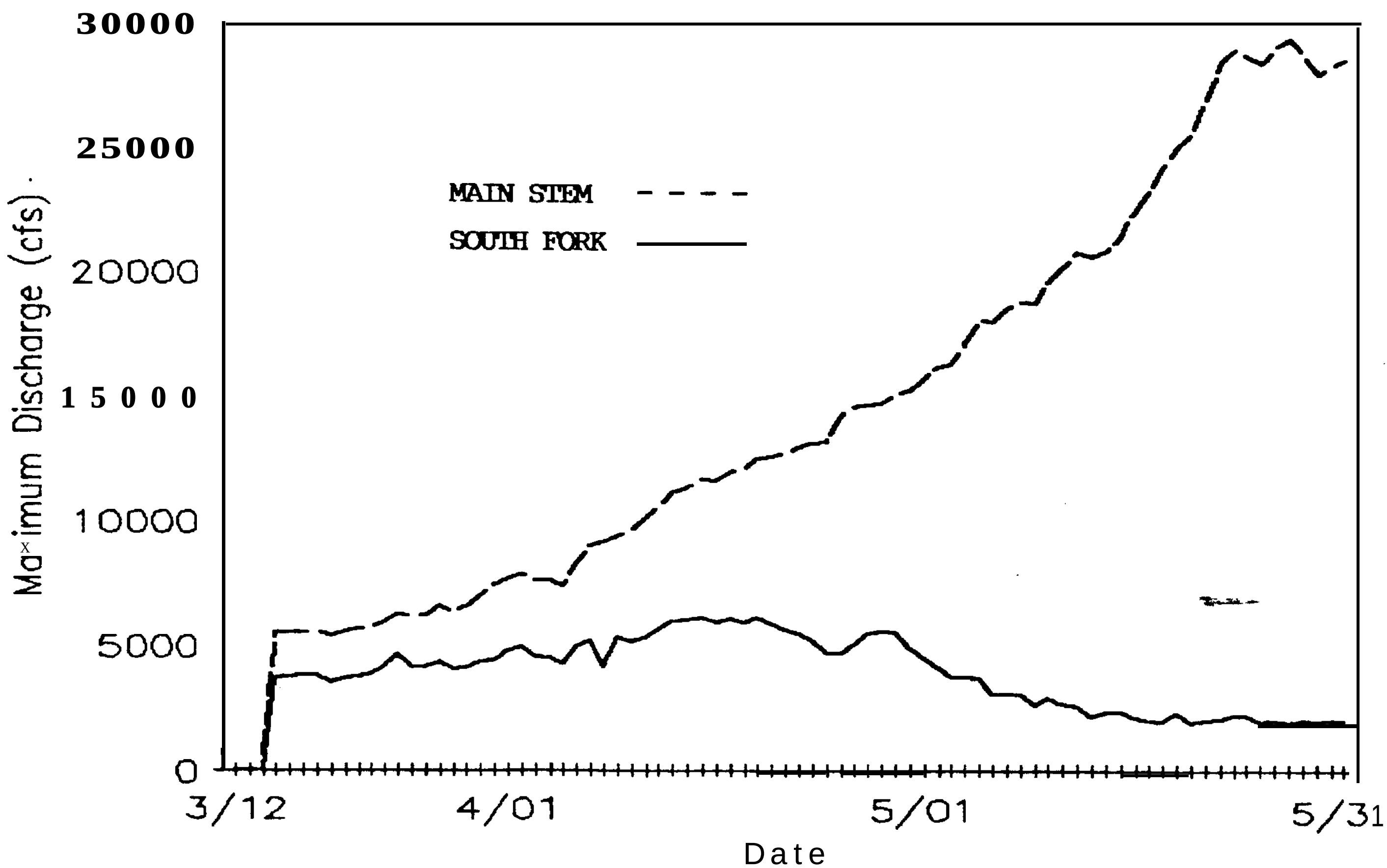


Figure 23. **Mean daily discharge, South Fork and main stem Flathead River at Columbia Falls, Montana, March 12 - May 31, 1950-1986.**

effects and the breeding ecology of these species in the study area were summarized by Mace, et al. (1987).

Large-scale habitat losses at the north shore of Flathead Lake undoubtedly led to corresponding losses in a variety of wildlife populations, including white-tailed deer (Odocoileus virginianus), furbearers, and a wide variety of both game and nongame bird species. In this latter category, we documented the loss of the delta cattail island which was utilized by ring-billed gulls (Larus delawarensis), common terns (Sterna hirundo) and spotted sandpipers (Actitus macularis) as nesting habitat. Terns and gulls resorted to nesting on delta stumps, where most if not all nests were destroyed by flooding. We documented the loss of at least five such nests to flooding in late May 1986. Two species of diving birds, the western grebe (Aechmophorus occidentalis) and common loon (Gavia immer), may also have lost important nesting habitat as a result of the construction and operation of Kerr Dam. Both species are dependent on small islands and floating vegetation for nesting. Flocks of grebes and at least one pair of loons were observed throughout the breeding season, but no nests or young were seen.

The most important other species which incurred large-scale negative effects as a result of habitat losses on the north shore of the lake were the numerous duck species known to nest in the area. Primary among these are the mallard (Anas platyrhynchos), redhead (Aythya americana), canvasback (Aythya valisenaria), and cinnamon teal (Anas cyanoptera), but several other species also breed in the area. Nest searches conducted by the USFWS in 1985 on the north shore of the lake located only three duck nests on 335 acres (Hall and Lord 1986). This results in a density of one nest per 111.6 acres; the highest densities at any WPA in Flathead or Lake counties in 1986 was one pair per 5.2 acres (Hall and Lord 1986). Most duck species require open water and emergent vegetation in close proximity early in the breeding season. The use of such areas is particularly important during the period when pair bonds are formed and mating takes place, which is typically early in May for mallards. At this time, the lake is usually still well below full pool, and few such areas are available to ducks. Many of the habitats which were lost on the north shore were suitable for duck nesting, and were replaced by seasonally flooded mudflats and cattail stands, which are poor duck nesting habitat. Lack of suitable duck brood-rearing habitat may also limit use of the north shore. We saw no duck broods during activity budget surveys in the WPA. The continued spread of Butomus may create more duck nesting and brood-rearing habitat over time, but without pair habitat, it is unlikely that north shore habitats will support increased duck populations.

DISCUSSION

VATER LEVEL EFFECTS

The relationship between fluctuating water levels and the distribution and habitat use patterns of geese during the non-breeding season were difficult to assess. Warmer releases from Hungry Horse Reservoir keep downstream river areas free of ice under some winter conditions, providing habitat which is otherwise not available during the coldest winter periods. Use of such areas has the potential of making birds more susceptible to hunters. The operation of Kerr Dam influences the entire river reach below Kalispell, and Flathead Lake, the areas most important as feeding and resting areas for geese during fall and winter. Direct effects of falldrawdown were not recorded, but as water levels drop in October and November, deeper submerged beds probably become available for feeding. Geese are also afforded some security by the mudflats exposed on the north shore, as the opportunities for predators to stalk or hunters to set up blinds are reduced. These positive effects are speculative, however, and it is clear that the primary effects of both Hungry Horse and Kerr Dam operation occur during the nesting and brood-rearing period.

Habitat Losses

North Shore

Large-scale losses of goose nesting habitat occurred and continue to occur on the north shore of the lake, due to the operation of Kerr Dam. The entire delta island area, at least 400 acres in size when the dam was built, was likely used for ground nesting. An average of 13 ground nests were found there between 1953 and 1960 (Geis 1956, Craighead and Stockstad 1961). As recently as 1982, 11 ground nests were found on the delta (Ball 1983). Over the last four years (1984-1987), the last of the vegetation has disappeared to erosion, and ground nests in the area have dropped from eight to two. It is evident from our data that as the remnant islands diminished, ground nesting pairs moved onto the mudflats of the delta, where predators and flooding destroyed most of their nests.

Given the predominance of tree-nesting in this population, it is highly likely that the 500 or more acres of forest habitat which were lost on the north shore also supported goose nests. Remnant stumps, currently an important component of north shore nesting habitat, are not as secure as tree sites for nests. Flooding destroys some such nests, but the greatest risk to these sites is the continued erosion during full pool periods. Not only are stumps being lost at a rate of nearly 13 percent a year, but those used for nesting are apparently even more susceptible (33-89 percent per year). Using a constant loss rate of 13 percent per year, Mace et al. 1987 predicted that all free-standing stumps on the delta will be gone by the year 1994 (Figure 24). While annual erosion rates obviously can be expected to vary, it is clear that all nesting potential in the delta will be lost within the next decade. This represents a loss of 22 nesting pairs (1985, 1986). assuming that these birds are unable to relocate successfully. Such a loss would represent approximately 16 percent of the breeding population in the northern Flathead Valley. Ground (marsh)nesting attempts elsewhere in the WPA increased by four between 1986 and 1987, while those on the delta decreased by five. This may be evidence that delta birds are attempting to relocate, however, one of these was a renesting attempt. Success rates for marsh nests are also the lowest of all nest types: ten of 14 known-fate marsh nests in the WPA failed due to predation in 1987.

Erosion losses due to Kerr Dam have also affected brood-rearing habitat on the north shore. Most (63 percent) of the habitat lost included herbaceous cover types which were likely used by geese during the brood-rearing period. The pastures and herbaceous shoreline areas along the north shore provided known brood-rearing habitat. Barraclough (1954) documented the use of the north shore by broods during 1953. The delta area provided several acres of good brood-rearing habitat including ponds, adjacent wet meadows and shoreline areas. All of these areas have eroded away.

It is likely that even after construction of Kerr Dam, broods continued to utilize these areas. However, once erosional processes on the Somers side stabilized, stands of cattails began to replace the herbaceous areas used by broods. Today extensive cattail stands separate the open water from the upland herbaceous areas. During our brood activity budget surveys, we rarely documented broods utilizing the cattails except for brief periods of time when they were disturbed. Even then only the outermost cattails closest to the water were used. We never observed broods in upland areas beyond the cattails.

The direct loss of habitats important to brood-rearing geese and the development of extensive cattail areas wouldhave had a more serious negative impact on the goose population without the establishment of Butomus The importance of this species as a primary food source for broods on the north shore was well documented by our research. The fact that Butomus exploits a habitat apparently unfavorable to any other species implies that without this species brood habitat would be very limited on the north shore. Although we have no clear evidence of how or when Butomus was first introduced into the lake, we suspect that the number and size of stands were very limited until recent years. Notable expansion has occurred between 1985 and 1986 (J. Jourdonnais, pers. commun.).

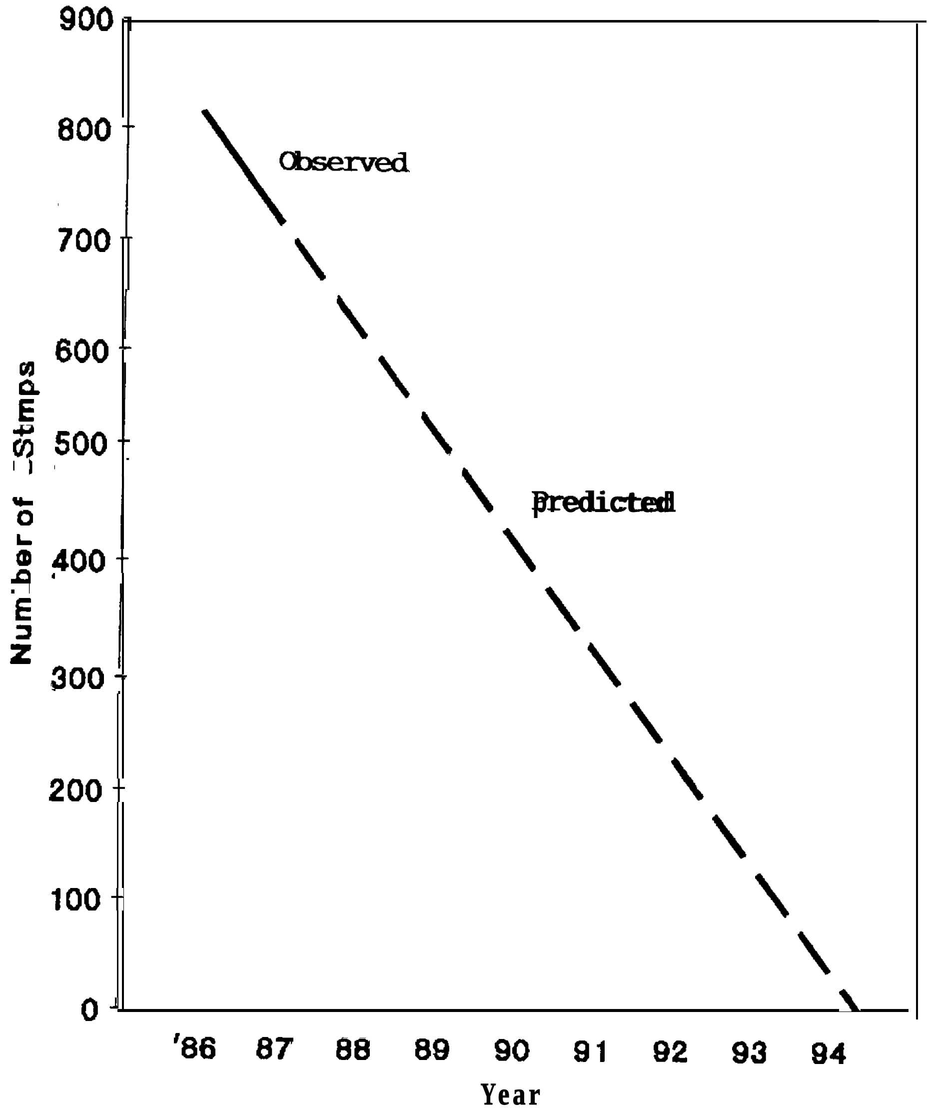


Figure 24. Estimated future erosion loss of Flathead River delta stumps used by nesting geese, northern Flathead Valley, Montana.

Time budget data provided insight into the quality of remaining brood-rearing habitat on the north shore of Flathead Lake. Deviations from optimum use of time and resources affect energy balance and should only occur when an individual or population encounters altered or changing environments (Burton and Hudson 1978). Water level fluctuations can affect brood time (hence energy) budgets through direct changes in food availability (e.g., unvegetated mudflats), or through the increased energy demand resulting from the use of open water as escape cover (i.e., travel between feeding areas and cover). Matthews and Mackey (in prep.) compared time budgets of broods on the south end of the lake and the Flathead River below Kerr Dam in order to identify factors limiting brood survival. They implied that brood habitat is limiting on the lake, based on the fact that goslings there spend more time feeding (50.6 percent) than do birds on river brood-rearing areas below the lake (39.6 percent of time spent feeding). Since time spent obtaining energy relates directly to energy needs (Schoener 1971), birds in energy stress need to feed more. Birds on the north shore of the lake spent 48 percent of their time feeding. The broods on the north end also spend less time resting (10.6 percent) than either of the population segments discussed by Matthews and Mackey (16.5 and 28.9 percent). These data indicate that brood habitat on the north shore is suboptimal, and that charges whichhave occurred since Kerr Dam was built have likely put an energy stress on broods reared on the lake. The fact that time spent alert by adults with broods (25.8 percent vs. 27.8 and 39.4 percent for the south end of the lake and river) indicates that disturbance level does not contribute significantly to the increased energy needs of geese on the north shore.

Matthews and Mackey (in prep.) noted that as water levels rise, broods on the lower half of FlatheadLake spent more time grazing in upland areas as access to those areas improved, with a corresponding dramatic (31x) shift away from the use of marsh areas. Cover type use differed dramatically at the north end of the lake, where use of marsh was highest (75.8 percent) at full pool. This difference is important in two ways. Given the choice, geese apparently prefer shortherbaceous to marsh cover types when open water is available nearby. At the north end of the lake, shortherbaceous (upland) habitats have been lost, and access to such habitat is limited by cattail growth. The extent and preference for *Butomus* at the north end are extremely important in off-setting these changes by providing a succulent, apparently nutritious food source for broods.

Lower River

Losses of nesting and brood-rearing habitat have also occurred over time along the river reach below Kalispell. These losses included 135 acres of deciduous forest which has been replaced by seasonally flooded mudflats. Deciduous forest habitat supports 95 percent of the annual nesting effort on that river reach, so it is very likely that these forest stands were used by tree-nesting geese. Approximately 162 acres of natural herbaceous areas lost in this area were probably used by broods, particularly those areas along the margins of oxbow sloughs (e.g., Fennon, Church), and at the mouth of creeks (e.g., Mill Cr., Swim Cr.).

Nesting Success

Displacement of geese into less secure nest sites (as discussed above for the river delta) is but one of the effects that water level fluctuations have on goose nesting success in the study area. Both predation due to land-bridging and flooding due to water level fluctuation were recorded as causing nest failures.

An important component of this study was to determine if the operation of Hungry Horse Dam put river island nests at risk, either through abnormal dewatering of high water channels which otherwise afforded nests with protection from mammalian predators, or through abnormally high flows which resulted in flooding. River island nests generally had a higher annual success rate than marsh nests (Table ll), but had a lower success rate than tree nests. On the average, 36 percent of island nesting attempts in the study area fail each year. Seventy-two percent of all ground nest failures were due to predation, 10 percent were due to abandonment, and 15 percent were due to flooding.

Flooding of Nests

The percentage of nests lost to flooding on an annual basis was consistently low ($\bar{x}$ = 2 percent, range 0 - 3 percent), for the study area as a whole. However, four of 40 nesting attempts, or 10 percent of the river island nesting effort for 1984-1987 on the reach most influenced by Hungry Horse Dam for 1984-1987, failed due to flooding (Table 34). Three of these nest failures happened as the result of natural high flows due to early runoff. Releases from Hungry Horse Dam may have contributed to the flooding of one of the nests, although it too occurred during a period of very high runoff (North and Middle forks = 34,800), andnatural flows out of the South Fork would likely have been far greater than the daily maximum (5,010 cfs) released from the dam on that date (May 25, 1985).

The average annual peak flow at Columbia Falls for the years 1966 - 1987 was 44,146 cfs (range 19,700-77,600). Annual peak flow occurred in April (once) or May a total of 16 of these 22 years. Peak flows occurred before May 15 (when nests would be at risk) in only four years. Three of the four documented ground nest failures due to flooding occurred at annual peak flows. Only one of these was a late renesting attempt.

Table 34. River discharge and lake level data for Canada goose nests lost to flooding, northern Flathead Valley, 1984 to 1987.

Nest No.	Nest Type	Date Flooded	River Discharge[a/] (cfs)	Lake Elevation[b/]
G01	River island ground	05/04/85	31,350	--
G31[c/]	River island ground	05/25/85	39,900	--
B43c/	Delta stump	05/29/86	--	2890.7
Hll	Delta ground	04/29/86	--	2886.0
H12	Delta ground	04/29/86	--	2886.0
B67c/	Delta stump	05/10/87	--	2889.1
B74c/	Delta stump	05/15/87	--	2890.5
103	River island ground	05/01/87	37,650	--
104	River island ground	05/01/87	37,650	--

a/ Daily maximum discharge at Columbia Falls (USGS gauge).
b/ Taken at Kerr Dam.
c/ Apparently a renesting attempt.

As erosional losses in the delta area forced ground-nesting pairs to attempt nesting on the unvegetated delta, their susceptibility to flooding increased dramatically. Two such nest failures were recorded in 1986 (Table 34). Both nests were at elevations of 2,886 ft, on the outer edges of the delta, but even those on the center portion, where average elevations were 2,888 ft. would be at risk in many years. During the four years of our study, the lake reached this 2,888 ft as early as May 6 and no later than May 24. Lake levels reached 2,891, the average elevation of delta stump nests, as early as May 19 and no later than June 3. Nest success on stumps is likely to be affected by wave action when the lake is still well below the nest elevation. Three stump nest failures due to flooding were recorded during the study; all three were likely to be renesting attempts based on egg stage data.

Dewatering Effects

The potential for nest failures due to flooding is greatest on those "islands" which become peninsulas at low flows, or which are connected to islands large enough to support predators. These HWC's are dewatered at low flows and provide access for predators. Thirty-eight of 150 islands in the study area fit this description.

A total of 11 nesting attempts were recorded over the four years on such sites, and seven of these attempts failed due to predation. None of these seven sites was used again the following year. The only successful nest at such a site was on an "island" that had a long series of other semi-islands and HWC's separating it from the shoreline. This pair nested successfully for two consecutive years, but did not return in 1987. We recorded one mainland ground nest over the four years. It was successful, but was not re-used the following year.

Review of historic flow data indicated that on the average, flows from the South Fork have contributed 44 percent of the daily mean flow at Columbia Falls during the period March 15 through April 30 in the years since the dam was shut. It is, therefore, unlikely that abnormally low flows are caused by the operation of the dam, during that period when ground nests are most at risk of predation.

In order to further clarify the relationship of specific water levels to dewatering and flooding effects, water level data were reviewed for 25 river sites at which opportunistic observations of flooding and dewatering were recorded. These included 11 individual islands, eight peninsulas which become islands at certain flows, and six portions of larger islands periodically isolated by high water channels. Seven of these areas included nest sites used during at least one year during the course of our study. By comparing our observations to USGS hourly discharge data, we were able to determine the flows at which certain sites were dewatered or flooded. Ten of the areas were gravelly peninsulas or small islands characterized by sparse cottonwood-willow regeneration stands. Nine of the ten were entirely inundated by flows ranging from 16,300 to 24,400 cfs. The remaining site was 75 percent inundated at 30,360 cfs. It was the only site of these ten which was used for nesting. That nest (GO3 t 1985) hatched, in spite of narrowly avoiding being flooded (water 0.5 m from the nest). This pair did not return to use the site in subsequent years.

The other 15 areas for which we collected dewatering/flooding data had a more diverse cover type distribution, primarily young deciduous forest stands interspersed with shrub and herbaceous types. Only one of these was completely inundated at 34,200 cfs; flows of 39,690 cfs were adequate to flood eight of the sites, with the others ranging from 30 to 75 percent flooded at this flow. Five of the areas (three islands, one peninsula, one portion of a large island) supported at least one nesting attempt during the study period.

These data support the premise that avoidance of small island and sparse shrub types by nesting geese is related to flooding and dewatering effects. It is apparent that whether a goose pair will use a given island for nesting during a given year depends on its history of flooding and/or dewatering (and subsequent predation). Failures of either type, over time, will cause a shift in nesting to more secure sites. This is accomplished either through active avoidance of such sites by pairs in subsequent years, or through the failure of pairs which consistently use such sites to successfully raise young which would return to natal areas to nest. In the latter case, as pairs die, the areas they occupied would no longer support nesting pairs unless young recruited elsewhere pioneered into such sites. It is likely based on our data that some mechanism such as these accounts for the very low nesting effort on the river above Kalispell.

Dewatering effects were also noted at the Flathead River delta, where the extended period of minimum pool (61 days) in 1987 caused land bridging to delta nesting areas. As a result, ten stump nests and one ground nest on the delta failed due to predation. Though crows were observed in the stump areas on several occasions, many of these failures were likely to have been caused by a red fox which was reportedly seen going from stump to stump early in the nesting period (M. Lorang, pers. commun.).

MANAGFiMENT/MITIGATION IMPLIGATIONS

The identification of limiting factors for the goose population, the role that water level effects play in those factors, and potential mitigation techniques to offset such effects were the primary goal of the study. Results of this study have important additional implications to both the methods used to monitor goose populations and the approaches used to mitigate water level effects in the Flathead Valley and elsewhere.

Survey **Techniques**

Annual pair surveys have traditionally beenusedto monitor the level of nesting effort throughout the Flathead Valley. Population goals, however, have been expressed as the number of breeding pairs (i.e., Ball 1983). Thus, while comparison of annual pair surveys can serve as an index to the breeding effort, without a clear idea as to the pair/nest ratios for given segments of the population number, the number of nesting pairs cannot be calculated accurately. We determined that this ratio averages approximately 1.17 pairs/nest for the north shore of the lake and the river below Kalispell, and 0.78 pairs/nest on the river reach above Kalispell (Table 4). Using these mean ratios to estimate nesting effort for a given year can result in drastic under or over-estimation, however. For the three years we analyzed (1985-1987), the predicted number of nests varied from -17.1 percent to t24.5 percent of the knownnesting effort on the north shore of the lake, and from -24.7 to t20.8 percent of the known nesting effort on the river below Kalispell (Table 4). Nesting effort on the river above Kalispell would have been underestimated by as much as 25 percent. It is obvious that some level of nest searching must be done on an annual basis if population trends are to be described, whether as an assessment of management or of mitigation goals.

Given the rapid deterioration of delta habitats, and the question of whether these displaced breeders will nest elsewhere on the north shore, known nesting areas in Flathead WPA (Appendix 0) should be searched annually. The majority of river island ground nesting takes place in the river reach we refer to as the braided section, immediately below the Old Steel Bridge at Kalispell. This area should also be searched for nests on an annual basis.

In addition to the annual pair survey flight, at least one and preferably two aerial surveys of the tree-nesting effort on the river below Kalispell should be conducted. A fixed-wing survey of all elevated nests conducted during the second week of April and a helicopter search for snag nests shortly thereafter (and no later than April 30) should identify the majority of nests in this reach, if the areas known to be used during this study (Appendix 0) are searched thoroughly. Helicopter searches during our study resulted in the discovery of an average of eight new nest sites each year.

Annual production has traditionally been monitored through the use of single annual aerial brood surveys. These should be continued, and should include intensive efforts at each of the consistently used brood areas we identified during this study (Appendix K). Our results indicate that aerial brood surveys account for approximately 65 percent of the predicted hatch, even when the maximum count out of several was used. Thus, aerial brood survey results should be used with caution, particularly if nest search (and nest fate determination) efforts are limited.

Nest Site Availability

The availability of secure nest sites is limited in much of northern Flathead Valley. This is especially true on the north shore of Flathead Lake, where erosional losses due to the operation of Kerr Dam have destroyednestinghabitat. The lack and continued loss of delta vegetation and stumps will influence the potential for reaching the population goal for the north shore, which was identified as 120 nesting pairs (Flathead Valley Goose Committee, 1986, unpubl. data). A loss of a minimum of 22 secure nest sites is anticipated within ten years at the WPA. These losses could be mitigated through an extensive nesting structure program, if structures were placed in areas secure from erosion. Whether ground-nesters from the delta will be able to relocate successfully is unlikely based on our data. Alternative ground nest sites in marshes are the highest risk sites used in the area, and it is likely that ground-nesting geese will not move on to structures.

The availability of secure nest sites is also limited on the Flathead River above Kalispell, where periodic flooding and land-bridging limit the suitability of river islands. The operation of Hungry Horse Dam may have contributed to some flooding in its early years of operation, but in recent years the dam has not caused abnormally low flows during the nesting season, and has served a flood control function in two of four years. Nonetheless, this river reach supports few nesting geese and thus has much room for enhancement, either to meet management goals or mitigation objectives. An intensive structure program on this river reach might increase numbers over time, as young are recruited from the four elevated nest structures already in place on this reach. There was no indication that any surplus adults are present along this reach, as was the case where structures were extremely successful elsewhere in the Flathead system (Mackey et al. in prep.). Only extreme water level manipulations could improve the security of these river islands.

Though very few islands are available for nesting on the Flathead River below its confluence with the Stillwater River below Kalispell, an abundance of natural elevated nest sites are available. The rapid increase in osprey populations over the last 15 years (Mace et al. 1987) has provided tree-nesting geese with an abundance of potential nest sites in addition to natural broken-topped snags. Protection of the areas where old growth cottonwood stands are available would guarantee nest site availability into the future. Populations could be supplemented in certain areas along this river reachthroughthe use of tree-nesting platforms such as those described by (Mackey et al. in prep.), in those areas where old growth stands are not available.

Nest Structures

Relatively few nest structures for Canada geese have been erected in the northern Flathead Valley compared to elsewhere in the region (Mackey et al., 1987 in prep.). We were aware of 23 structures put up by private interests and 12 put up by the USFWS (in Flathead WPA). Eleven of these 35 structures were used at least once for nesting. Five of the structures (each of which was used for nesting) were wire baskets on low posts over water. Low nesting success at these sites contributed to the low overall success rate for structures (64 percent) as compared to the elevated structures described by Mackey et al. (1987, in prep.). Many of the other structures, including three tripod platforms in the WPA and one on the lower Stillwater River, contained no nesting material. Seven nest boxes on tall wooden posts were erected in the WPA in 1987. One was occupied, and more may be colonized as delta stumps are lost to erosion.

We experimented with three types of structures during the course of our studies. Geese were known to nest on four existing osprey nest structures over the four years. Given that only one osprey nest was available on the upper river reach, we erected eight structures by placing platforms on topped trees on a USFS-owned island. Our hope was that both geese and ospreys would use such sites, providing maintenance-free structures for the life of the tree. One such site, used by ospreys in 1986, was used by geese in 1987. Provision of a dummy nest on the platforms improved acceptance by ospreys. Without such efforts in 1985, no use of the sites was recorded. Our second effort to provide artificial nest sites took place in 1987, when we modified two stumps eroded into tubes by nailing hardware cloth to the interior and filling this with bark chips. One of the two sites was used, but failed due to predation. In areas (elsewhere) where stumps are not threatened by erosion, this technique might serve to increase nesting efforts. Lastly, we put up two of the nest structures described by Mackey et al. on a privately owned slough west of the upper river in 1987. One was occupied by a nesting pair within ten days. The fate of this nest was unknown.

Nesting Success

Nesting success of Canada geese in the northern Flathead Valley varies dramatically between nest types and between years (Table 11). Achieving management or mitigation goals through improvement of nesting success would therefore require changing the ratio of highly successful types (i.e., tree nests) to those with poor nesting success (i.e., marsh nests). This could be done by erecting nest structures in marsh areas, but it is unknown whether marsh ground-nesters will shift to such sites.

The average nest success rate we observed for this population was 69 percent, slightly lower than the 73 percent figure reported by Krohn and Bizeau (1980) from studies throughout much of the western U.S. Still, this rate of nest success seems adequate, under existing mortality regimes, to allow the population to remain stable or to increase. Given that ground-nesters and tree-nesters are apparently distinct segments of the population, it is likely that the ratio between the two will change naturally, based on the differential in their success rates, and that overall nesting success for this population should gradually increase. This will occur only to the extent that suitable nest sites are available for the new birds produced.

Changing overall nest success through the manipulation of water levels is another option. Operating Hungry Horse as a flood-control facility during years of early runoff could achieve this for the upper river, but would only affect less than ten percent of the annual nesting effort. Because flooding potentially affects approximately 10 percent of the river island nests, and runoff is only early in certain years, the effect of such an approach on overall nesting success would be minor.

Predator control, or the reduction of losses to predation through water level manipulation, would improve overall nesting success by decreasing the most prevalent cause of nest failures in the study area. Predator control is a controversial management strategy and therefore difficult to implement. The influence of a single predator can be drastic, however, as indicated by the apparent destruction of as many as ten stump nests by one fox which gained access to the river delta during the exceptionally low water levels of 1987. Preventing such access would be a suitable means of enhancing nest success, but for the fact that nesting habitats in that location will soon be lost completely. A reduction of land-bridging to river islands, through supplemented flows early in the nesting season, could also reduce nest losses to predation.

Brood-rearing

The question of whether brood habitat availability limits the goose population in the northern Flathead Valley was not easily answered by the results of this study. Extensive losses of brood habitat have occurred and continue in the single most heavily-used brood-rearing area (Flathead WPA), as a result of the operation of Kerr Dam. Mitigating this loss and additional losses could be achieved by improving the quality of the existing brood-rearing areas. Brood habitat in the WPA is currently able to support large numbers of broods only due to the fortuitous appearance of

Butomus. Because of its local importance to brood-rearing geese, we reviewed information on this species. The plant was introduced from Eurasia and was first observed in the Great Lakes region of North America in 1897 (Stuckey 1968). The species invades marsh and lake shoreline areas and apparently has a wide tolerance for water levels (A. Schuyler, pers. comm.). Although we have not discovered specific documentation of when it was first observed on Flathead Lake, it was reportedly here during the early 1960's. The University of Montana's herbarium curator reported finding Butomus sometime during the early 1960's (T. Weaver, pers. comm.).

Wildlife refuge managers in the Great Lakes region were contacted to discuss the impacts of Butomus in their areas. Although fairly common in occurrence, they did not recall ever seeing geese specifically using this plant for forage (K. Bednarik, pers. comm.). In addition, as far as they could tell Butomus had not replaced any other species. Early articles on Butomus expressed concern that indigenous riparian vegetation such as Scirpus and Sparganium may be displaced (Dansereau 1957).

The WPA could be enhanced for brood-rearingthroughhabitat manipulation. Access to secure upland herbaceous areas could be opened up by removal of shoreline debris and cattail stands. More security for broods would be provided by raising lake levels earlier in May, but would reduce the capability of Kerr Dam to contain spring runoff.

Mitigation for brood-rearing areas inundated on the lower river would require protection and enhancement of existing sites, because all areas are found on private lands. It may be possible in certain areas to "create" brood habitat by introducing Butomus onto unvegetated mudflats on the lower river. We decided to test if Butomus could be easily transplanted to other areas to provide forage for broods. In May 1987, we transplanted 59 stems to a 1 m2 site on a bare mudflat in the lower river. Ten days later the site was revisited to check for survival. Although the shoots appeared to be alive, the plants had been grazed so that only 3 cm of shoot remained.

Brood areas along the lower river would also benefit from earlier spring increases in lake elevation. The higher water levels would provide quicker access for broods from the herbaceous feeding sites thereby reducing the possibility of predation.

Effects of the operation of Hungry Horse Dam on brood-rearing habitat are less clear-cut. Gur research indicates very minor if any, impacts occurred on the few brood-rearing areas found on the portion of river influenced by Hungry Horse Dam. However, because the amount of brood-rearing habitat is limited on the upper river, management should be directed toward protection of the identified areas (Appendix K). Though our data indicate that geese do not necessarily need brood-rearing habitat immediately adjacent to nesting areas (as evidenced by extensive brood movements), creation or enhancement of upper river areas would likely improve the chances of increasing populations in the area, if combined with a nest structure program.

Habitat Protection

Protection of those habitats which are currently used by geese, but threatened by erosion due to water level fluctuations, is a desirable management strategy; but not one easily achieved. Protection of north shore habitats through water level manipulations would require drastic changes in the operation of Kerr Dam which would conflict with power generation and recreational use of Flathead Lake. Diking could protect some of the most important threatened areas if designed properly, but is also a high-cost approach.

Currently-utilized areas, or areas whichhave potential for enhancement, could be protected from future detrimental habitat changes other than erosion, through the use of easement or acquisition with subsequent habitat management. We have identified important brood-rearing areas (Appendix K), nesting areas (Appendix 0). and the habitat characteristics of such sites which make them suitable. These data should be used in the development of criteria to rank potential easement/acquisition properties in the northern Flathead Valley. Such properties might be selected as mitigation sites, for losses identified in this document, or for habitat losses elsewhere, or they might be selected (or offered) as lands to come under agency management (i.e., fishing accesses, Waterfowl Production Areas) exclusive of any mitigation processes.

SUMMARY AND CONCLUSIONS

POPULATION STATUS

The number of known Canada goose nesting attempts recorded in the northern Flathead Valley ranged from 44 in 1984 to 108 in 1985, to 135 in both 1986 and1987. These increases reflect, at least in part, our increased proficiency at finding nests as we identified nesting areas (e.g., delta stumps, various marsh areas, natural snags). An average of 15 nesting attempts took place annually on the delta stumps, an area influenced strongly by water level changes caused by the construction and operation of Kerr Dam. This stump-nesting effort had not been recorded by previous researchers.

An average of 54 percent of ali annual nesting attempts were at elevated sites, including nests built by other species (primarily osprey), natural snags, stumps, and nesting structures. Nesting success varied from 58 to 81 percent, and averaged 68 percent for the four years. The primary cause of nest failure was predation, but flooding caused the failure of 10 percent of all ground nests in the river reach influenced by Hungry Horse Dam.

Estimated annual production for the northern Flathead Valley averages more than 400 goslings. Nine important brood-rearing areas were located primarily at pasture or natural herbaceous sites adjacent to off-river aquatic habitats, with the exception of the Flathead Waterfowl Production Area. This was the most heavily-used brood-rearing area, and represents an important security area for geese during the molting period and through the winter.

HA BITAT STATUS

Analysis of aerial photos taken prior to construction of Kerr Dam documented the loss of terrestrial habitat on the north shore and the lower river below Kalispell. Losses were attributed to inundation and continuing erosion due to operation of Kerr Dam. Impacts on the north shore included the loss of 1,859 acres of habitat, the conversion of approximately 205 acres of herbaceous cover type to cattails, and the establishment of 121 acres of Butomus. Most of the habitat lost included herbaceous cover types (1,179 acres) and deciduous forest (571 acres).

Approximately 335 - 339 acres of habitat were inundated on the lower river including 162 acres of herbaceous sites and 135 acres of deciduous forests. Unvegetated habitats totaled 110 acres, and 66 acres of this total were converted to emergent vegetation (cattails). Thus a net loss range of 235 - 273 acres of terrestrial habitat along this river reach has occurred.

Most (73 percent) ground nests in the area were less than 1 m above the seasonal high water mark, and most (63 percent) ground nests were less than 2 m from the HWM. Ground nests were found primarily in deciduous forest cover type (48 percent) or in dense shrub (29 percent).

Patterns in selection of river islands for use as nest sites indicate that geese select against the smallest available islands, and against sparse shrub sites. This reflects the likelihood of such sites to flood: most are gravelly islands which are inundated regularly by high flows. Most tree nests were in very large cottonwoods (mean dbh - 0.98 m). Most (62 percent) of the trees were less than 10 m from the HWM, which indicates that such sites may be at risk of erosion during full pool periods. The average height of the base of nesting trees above the HWM was 1.04 m and most (62 percent) were less than 1 m above the high water.

Ease of access to marsh nest sites made them particularly susceptible to predators. More than half of the marsh nest sites (55 percent) were less than 10 m from open water and most nests (64 percent) were at least 20 m from upland areas. Water depth at the nest site averaged 0.63 m.

Pasture brood-rearing sites were dominated by dense grass (72 percent) and forbs (25 percent). Over 35 species of plants were listed at these sites. These sites were primarily in areas not influenced by water level fluctuations.

Natural herbaceous sites used by broods included wet meadows, stream banks, and sandbars. These sites were usually less than 0.5 m above the high water, however, only the sandbar sites were flooded by high flows. Sites were dominated by grasses (72 percent) and forbs (21 percent). Over 47 plant species were identified at these sites.

Marsh sites were found in the off-river sloughs and were used for security, loafing, and some feeding. Cattails (45 percent) and bulrush (52 percent) dominated these sites. A unique marsh site was found on the WPA where Butomus dominated (85 percent) the mudflat area beyond the cattails. Very few other species existed.

Cultivated fields were used by broods in two areas and were associated with other brood area components (marsh, herbaceous). Both sites were barley fields, and small areas were grazed close the open water.

SUMNARY OF WATER LEVEL EFFECTS

This study has identified specific losses due to construction and operation of Kerr Dam, and potential losses and gains due to the operation of Hungry Horse Dam. The primary and most significant effect of Kerr Dam on geese has been the loss of a minimum of 1,850 acres of nesting and brood-rearing habitat on the north shore of the lake, and an additional 273 acres or more of terrestrial habitats along the Flathead river below Kalispell. Whether this is considered a construction or operational loss is a moot point, because the erosion is ongoing. On the east side of the river mouth, tree nesting sites will be lost in the near future. During the course of our study, we have seen the loss of at least eight secure nest sites in the delta, as the last remnant of vegetation has washed away. Within ten years, all 22 nest sites we documented in 1985 in that area are likely to be lost to erosion. Twenty-two pairs represent 16 percent of the nesting population of the northern Flathead Valley. Over 1,200 acres of short herbaceous and small wetland habitats were lost along the north shore, and is likely that these habitats were important brood-rearing areas. Current brood habitat on the north shore is less than ideal (due to the extensive mudflats), but due to the appearance of Butomus umbellatus the geese apparently are capable of having productive years by brooding there (e.g., 1986).

The upriver effects of Kerr appear to be somewhat limited, although long-term habitat changes have probably changed the availability of preferred habitats. Few, if any, positive changes have occurred. "Created" marshes are not high quality for nesting or brood-rearing. Tree-nesting is most prevalent in this area, and the continued success of geese is closely tied to the expanding osprey population. Some loss of nesting habitat (cottonwood stands) apparently occurred in areas such as Fennon Slough, as indicated by the current distribution of stumps below the full pool elevation. Where ground nesting does occur (off-river sloughs/potholes), predation is a major problem. Although this predation is unrelated to dam operation, it has important ramifications for developing mitigation options.

On the upper river reach (above Kalispell), there is essentially no tree nesting, and the number of island groundnests is limited in comparison to available habitat. This indicates that flooding during the nesting season has limited goose production in this segment of the population.

As it is currently operated, Hungry Horse Dam is not having a significant effect on downstream island nests. Some protection is afforded to island nest sites by flows in the early nesting period which are supplemented above natural levels with releases from the dam. Over time, high flows during the nesting period have limited the nesting effort through the periodic flooding of islands; currently, the only sites which are being used for nesting are those which only flood at exceptionally high water levels (>30,000 cfs). Drastic daily fluctuations in river water level occur frequently in most years, and have the potential for flooding nests of pairs "pioneering" lower elevation sites on islands. How often this occurred in the past is difficult to say, but in two of the four years of this study, Hungry Horse Dam served a flood control function by being run at or near base load during periods of early runoff.

MANAGEMENT/MITIGATION RECOMMENDATIONS

Several options are available for mitigating the losses caused by the operation of Kerr and Hungry Horse dams. These range from large projects such as a subimpoundment on the north shore to low cost projects such as nest structures (Table 35). A subimpoundment, while costly, would have multiple benefits and is, therefore, viewed as a preferred alternative for north shore habitat losses.

Subimpoundment (s)

Creation of one or more subimpoundments on the north end of Flathead Lake, also suggested by Bissell (1987). represents an extreme water level manipulation strategy which would have multiple benefits for geese and a variety of other species. A subimpoundment with islands and nesting structures would provide secure nest sites, brood-rearing habitat, and replacement habitat for a variety of other species (principally ducks and furbearers). Studies currently being conducted by Hauer et al. (in prep.) indicate that shoreline stability is being reached on the WPA west of the river. A subimpoundment inthatarea would be relatively secure from future erosional losses, if properly designed. An impoundment of one of the larger bays near the river mouth could serve to prevent future losses in that area. Such a project would require extensive advance design (engineering), to include dikes, a water control system including potential use of channels from the river to increase water level manipulation options, and islands.

Construction of a subimpoundment would require a multiagency effort, with the contribution from mitigation dollars meeting only some of the total cost. This option would have benefits far above other mitigation options, and would be consistent with mitigation goals of other studies (Mace et al. 1987; Bissell et al. 1987). The fact that the north shore is already under management as a Waterfowl Production Area would facilitate this process. The habitat potential of such a site would greatly increase the possibilities of reaching population goals set forth by the Flathead Valley Goose Committee, given that the nesting potential of the north shore is currently on the decline.

Habitat Acquisition

The purchase of fee title or easements on lands to be placed under management for geese could serve to mitigate habitat losses.

Table 35. Summary of Canada goose habitat losses and other water level effects attributable to Hungry Horse and Kerr dams, with ranked mitigation alternatives, northern Flathead Valley, Montana.

Facility	Water Level Effect	Net Loss(es)	Mitigation Alternative
Kerr	Erosion of North Shore Habitats	1,859+ acres (ongoing)	Subimpoundment with is lands[b] Easement/Acquisition of off-site areas Erosion control (diking) Water Level Manipulation
	Loss of Nesting Habitat	500+ acres, entire delta	(Subimpoundment) Nest Structure Program WPA Nest Structure Program, Upriver
	Loss of Brood-rearing Habitat	1,000+ acres	Habitat Manipulation/Enhancement, WPA [c] (Subimpoundment) Easement/Acquisition
	Nest Failures/Loss of Nest Sites (Land-bridging, flooding, erosion)	22 nest sites (on delta)	(Subimpoundment) Nest Structure Program[d] Water Level Manipulation Predator Control
	Erosion of Upriver Habitats	235-273 acres	Easement/Acquisition Water Level Manipulation (Regulate slough[s])
	Loss of Nesting Habitat	135+ acres (dec forest)	Nest Structures (Easement/Acquisition)
	Loss of Brood-rearing Habitat	162+ acres	Habitat Manipulation/Enhancement[c] (Water Level Manipulation) (Easement/Acquisition)
Hungry Horse Dam	Nest Failures (Land-bridging, flooding)	(1uJ)~	Nest Structure Program Enhance off-river sites Regulate discharge

[a] Ranked by multiplicity of benefits, longevity, proximity to project area, "cost-benefit" ratio.
[b] Highest cost, highest benefit; addresses losses of both nesting and brood-rearing habitat.
[c] Botomus transplants, burn/graze upland, cattail control to increase interspersion and access to feeding areas.
[d] Replace lost sites, shift low-success marsh nests to structures.
[e] Current ioeratoiin protects nests in some years.

Acreage goals should be based on anticipated population gains. Active habitat manipulation also should be scheduled for acquired lands.

The information we have collected on important use areas and habitat characteristics should be used to prioritize potential mitigation properties. We recommend Weaver, McWenneger, and Egan sloughs, and any of the largest old growth cottonwood stands currently used for nesting (Appendix 0) should receive primary consideration, as should important brood-rearing areas (Appendix K).

Habitat Manipulation on Lands as Currently Owned

Improvement of nesting or brood-rearing habitat on lands currently under public ownership could serve as a mitigation tool for such losses throughout the study area. Broodhabitat at the WPA could probably be improved through a program of controlled burns, cattail removal, and moderate grazing on upland sites. Such manipulations are currently being done to a limited degree. Provision of funds for activities beyond those planned by the USFWS would be required for such activities to be considered mitigation.

Some brood enhancement on currently unvegetated mudflats within the high water marks of the river and lake could be achieved through the transplants of Butomus stock from the WPA. This approach has very good potential, given the level of use of this species at the lake and its apparent ease of establishment.

Nest Structure Program

Losses of nesting habitat could be mitigated through an intensive program of nest structure placement, if such structures were placed in areas with some type of management agreement. These might include the WPA, any lands acquired as mitigation, State lands, USFS, or private land brought under easement. Possibilities include attempting to get unsuccessful marsh nesters to shift to short structures. Brosten's Pond, Flathead WPA, Egan Slough and McWenneger Slough represent areas that would benefit from additional structures. Placement of osprey structures or the type of structure shown to be effective on the lower Flathead River (Mackey et al. 1987, in prep.) along the river reach above Kalispell would improve nesting conditions and success in the area influenced by Hungry Horse Dam. The inherent assumptions of these two approaches are that 1) some ground nesters can be shifted to structures in a marsh environment, and 2)there is a surplus of young birds recruited from tree nests which would pioneer new sites if provided. The former assumption remains unproven for the northern Flathead Valley.

Water Level Management

Several options involving dam operation could reduce annual nesting losses. We now know the elevations of stump nests on the river delta. If we could put a cap on lake elevation until the nesting season was over, we might guarantee an increase in production, but this would be a short-term option at best given that all stumps may be gone within ten years. Bringing the lake up to the elevation of the delta before the nesting season, would prevent initiation of ill-fated delta ground nests, and might shift these birds to nesting areas elsewhere. Given the current configuration of the delta, a policy of holding the lake above 2.884.5 ft for at least the dry years in the next ten years would protect the last stump nest efforts from mammalian predation.

Brood habitat and survival would be improved by bringing the lake up earlier, which would involve some trade-offs with the delta nesting options above. Such approaches to management may also conflict with other considerations which govern the spring refill schedule, but may be possible in certain years when low runoff is predicted.

An ideal operational strategy to protect goose nesting would be to supplement flows early in the nesting period (March 12 - April 15), sufficiently to provide flows in high water channels deep enough to preclude mammalian predators from nesting islands. As natural flows began to increase, the ideal operation of the dam would prevent flows from exceeding 25,000 cfs at Columbia Falls, as late as possible (May 15 or later). Finally, daily and seasonal fluctuations would be minimized for the entire nesting period (March 12 - May 31). The current operation of the dam approximates these ideal scenarios, with the exception of the latter condition. Eliminating peaking operations during the nesting season would protect nests, but is probably not consistent with the other constraints which govern dam operation.

Elimination of the opportunity for geese to nest at lower elevations on river islands might also lessen the potential for nest flooding. Maintaining flows at some relatively high level during the peak of nest initiation (March 25 - April 10) would force the geese to nest at higher sites. If this flow level was high enough, then the dam could be operated so as not to exceed that level again until after nests had hatched (approximately May 10). A review of the mean flow data since 1954 shows that the flow value selected would need to be 15,000 cfs or greater, and this approach would require the dam to operate at about 11,000 - 13,000 cfs from March 25 until April 10, a scenario which may not be feasible in most years due to the resultant drawdown of the reservoir. Either of these operational scenarios to protect upper river nests would be affecting approximately 8 percent of the entire goose population of the northern Flathead Valley, and would need to be judged critically against other management options.

SUGGESTED FIJTOBE STUDIES

Given the historic and continuing losses of Canada goose nesting and brood-rearing habitat in the northern Flathead Valley, every effort should be made to monitor this population. We have suggested the addition of nest searches and aerial surveys of nests to the annual monitoring efforts of the USFWS and MDFWP.

Any mitigation projects implemented for the losses identified in this document, or for losses elsewhere in the Flathead Valley (i.e., Casey et al. 1984) which include portions of this study area should be monitored closely for the response of the nesting goose population. Mitigation through the use of nesting structures in marsh habitats will require a well-designed study to determine if geese nesting at ground sites in marshes will relocate onto structures. Such a study could easily be designed to accompany easement or acquisition of wetland sites currently used by geese for nesting.

Butomus may have greatpotentialas an enhancement tool for brood-rearing areas in the Flathead Valley and elsewhere. Due to its tolerance of fluctuating water levels, it seems particularly suited for reservoir situations where management for goose brood habitat is desirable. Further experiments should be conducted to determine the best methods to propagate or transplant this species, including soil preferences and timing in relation to water level changes.

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APPENDIX A

Daily maximum gauge height (ft) and discharge (cfs), South Fork and main stem Flathead River at Columbia Falls, March 12 - May 31, 1984-1987.

Mo. Day Yr	South Fork Gauge (ft)	South Fork Flow (cfs)	Main Stem Gauge (ft)	Main Stem Flow (cfs)
Mar 12 84	5.65	2260	3.21	4180
Mar 13 84	5.65	2260	3.26	4270
Mar 14 84	10.21	9840	5.28	8850
Mar 15 84	5.92	2590	3.42	4570
Mar 16 84	5.93	2600	3.38	4490
Mar 17 84	5.93	2600	3.39	4510
Mar 18 84	5.67	2280	3.20	4160
Mar 19 84	5.39	1960	3.01	3830
Mar 20 84	7.79	5250	4.59	7080
Mar 21 84	7.78	5230	4.20	6170
Mar 22 84	5.56	2160	3.31	4360
Mar 23 84	5.56	2160	3.34	4420
Mar 24 84	5.57	2170	3.35	4430
Mar 25 84	5.15	1700	3.10	3980
Mar 26 84	5.14	1690	3.09	3970
Mar 27 84	5.15	1700	3.07	3930
Mar 28 84	5.15	1700	3.04	3880
Mar 29 84	5.16	1710	3.03	3860
Mar 30 84	7.75	5180	4.45	6750
Mar 31 84	5.16	1710	3.02	3840
Apr 1 84	5.15	1700	3.00	3810
Apr 2 84	5.15	1700	2.99	3790
Apr 3 84	5.17	1720	3.00	3810
Apr 4 84	5.15	1700	3.03	3860
Apr 5 84	5.16	1710	3.19	4140
Apr 6 84	10.38	10200	6.64	13000
Apr 7 84	10.35	10200	5.59	9720
Apr 8 84	5.12	1670	3.49	4700
Apr 9 84	5.09	1640	3.56	4840
Apr 10 84	10.37	10200	6.77	13440
Apr 11 84	5.09	1640	3.62	4950
Apr 12 84	5.10	1650	3.56	4840
Apr 13 84	5.11	1660	3.52	4760
Apr 14 84	5.11	1660	3.47	4660
Apr 15 84	5.12	1670	3.59	4890
Apr 16 84	5.11	1660	3.77	5270
Apr 17 84	4.56	1140	5.05	8110
Apr 18 84	2.80	268	6.35	11910
Apr 19 84	3.37	468	6.66	13000
Apr 20 84	7.68	5070	7.59	16500
Apr 21 84	2.80	268	6.86	13790
Apr 22 84	2.79	265	6.56	12830
Apr 23 84	2.78	262	6.51	12560
Apr 24 84	10.25	9930	8.61	20650
Apr 25 84	10.26	9950	8.12	18570
Apr 26 84	10.24	9910	8.15	18700
Apr 27 84	10.16	9730	5.59	16700
Apr 28 84	2.61	211	4.82	7900
Apr 29 84	2.61	211	4.57	7350
Apr 30 84	10.22	9860	7.32	16080
May 1 84	10.24	9910	7.32	16080
May 2 84	10.24	9910	7.52	16160
May 3 84	10.26	9950	7.55	16270
May 4 84	10.28	10000	7.53	16200
May 5 84	2.74	249	4.18	16130
May 6 84	2.59	205	4.09	5930
May 7 84	10.19	9800	7.20	14970
May 8 84	7.63	4990	5.07	8290
May 9 84	10.25	9930	7.57	16350
May 10 84	10.25	9930	7.63	16580
May 11 84	10.24	9910	7.71	16890
May 12 84	2.51	183	4.94	7950
May 13 84	2.55	194	5.16	8530
May 14 84	10.18	9780	8.64	20740
May 15 84	10.18	9780	9.45	24450
May 16 84	10.20	9820	9.98	27060
May 17 84	10.11	9620	9.98	27060
May 18 84	10.21	9840	9.63	25320
May 19 84	2.76	255	7.51	16120
May 20 84	2.80	268	9.40	24210
May 21 84	10.10	9600	9.97	27010
May 22 84	10.20	9820	9.97	27010
May 23 84	2.85	284	7.87	17520
May 24 84	10.18	9780	9.73	25810
May 25 84	10.19	9800	9.63	25320
May 26 84	2.63	216	7.33	15440
May 27 84	2.64	219	7.01	14280
May 28 84	2.66	225	6.94	14030
May 29 84	2.71	240	7.51	16120
May 30 84	7.65	5020	10.44	29450
May 31 84	2.79	265	11.33	34390

APPENDIX A

Daily maximum gauge height (ft) and discharge (cfs), South Fork and main stem Flathead River at Columbia Falls, March 12 - May 31, 1984-1987 (continued).

Mo. Day Yr	South Fork Gauge (ft)	South Fork Flow (cfs)	Main Stem Gauge (ft)	Main Stem Flow (cfs)
Mar 12 85	10.62	10800	6.32	11900
Mar 13 85	7.54	4850	4.10	5950
Mar 14 85	7.53	4840	4.10	5950
Mar 15 85	7.54	4850	4.10	5950
Mar 16 55	7.55	4870	4.11	5970
Mar 17 85	7.54	4850	4.13	6020
Mar 18 85	7.54	4850	4.15	6060
Mar 19 85	7.54	4850	4.18	6130
Mar 20 85	7.53	4840	4.19	6150
Mar 21 85	6.11	2830	3.26	4270
Mar 22 85	6.11	2830	3.24	4230
Mar 23 85	6.09	2800	3.22	4200
Mar 24 85	6.09	2800	3.28	4310
Mar 25 85	6.09	2800	3.27	4290
Mar 26 85	6.09	2800	3.24	4230
Mar 27 85	7.48	4760	4.08	5910
Mar 28 85	6.13	2850	3.25	4250
Mar 29 85	6.08	2790	3.21	4180
Mar 30 85	6.12	2840	3.24	4230
Mar 31 85	6.11	2830	3.23	4210
Apr 1 85	6.12	2840	3.27	4290
Apr 2 85	6.12	2840	3.37	4470
Apr 3 85	6.13	2850	3.53	4780
Apr 4 85	5.77	2400	3.56	4840
Apr 5 85	5.46	2040	3.46	4640
Apr 6 85	4.89	1440	3.12	4020
Apr 7 85	4.88	1430	3.16	4090
Apr 8 85	4.88	1430	3.28	4310
Apr 9 85	4.91	1460	3.57	4850
Apr 10 85	4.91	1460	3.72	5150
Apr 11 85	3.74	623	4.83	7670
Apr 12 85	2.58	202	5.71	10100
Apr 13 85	2.54	191	6.18	11500
Apr 14 85	2.55	190	6.99	14200
Apr 15 85	2.58	202	7.56	16300
Apr 16 85	2.58	202	7.52	16200
Apr 17 85	8.47	6390	7.79	17200
Apr 18 85	2.57	199	7.21	15000
Apr 19 85	2.57	199	7.09	14600
Apr 20 85	2.53	188	6.66	13100
Apr 21 85	2.53	188	6.08	11200

Mo. Day Yr	South Fork Gauge (ft)	South Fork Flow (cfs)	Main Stem Gauge (ft)	Main Stem Flow (cfs)
Apr 22 85	2.52	185	5.63	9830
Apr 23 85	2.49	177	5.20	8630
Apr 24 85	2.49	177	4.96	8000
Apr 25 85	2.48	175	4.66	7250
Apr 26 85	2.50	180	4.42	6680
Apr 27 85	2.50	180	4.23	6240
Apr 28 85	2.54	191	5.01	8130
Apr 29 85	2.56	197	6.40	12200
Apr 30 85	2.59	205	6.95	14100
May 1 85	2.58	202	7.37	15600
May 2 85	2.75	252	8.59	20500
May 3 85	2.70	237	10.09	27600
May 4 85	2.71	240	10.60	30300
May 5 85	2.67	228	10.26	28500
May 6 85	2.77	258	8.94	22100
May 7 85	2.62	214	7.78	17200
May 8 85	2.63	216	7.73	17000
May 9 85	2.63	216	7.72	16900
May 10 85	2.64	219	7.74	17000
May 11 85	2.64	219	7.71	16900
May 12 85	2.64	219	7.53	16200
May 13 85	2.62	214	7.10	14600
May 14 85	2.64	219	6.74	13300
May 15 85	2.64	219	6.73	13300
May 16 85	2.67	228	7.58	16400
May 17 85	2.70	237	8.52	20200
May 18 85	2.78	262	9.32	23800
May 19 85	2.81	271	10.18	28100
May 20 85	2.87	290	10.74	31100
May 21 85	2.88	293	11.02	32600
May 22 85	2.92	306	11.34	34400
May 23 85	2.90	300	11.56	35700
May 24 85	7.63	4990	11.80	37200
May 25 85	7.64	5010	12.24	39900
May 26 85	2.89	297	11.94	38000
May 27 85	2.83	277	11.13	33200
May 28 85	2.81	271	10.05	27400
May 29 85	2.80	268	9.55	24900
May 30 85	2.84	281	9.66	25500
May 31 85	2.77	258	9.55	24900

APPENDIX A

Daily maximum gauge height (ft) and discharge (cfs), South Fork and main stem Flathead River at Columbia Falls, March 12 - May 31, 1984-1987 (continued).

Mo. Day Yr	South Fork Gauge (ft)	South Fork Flow (cfs)	Main Stem Gauge (ft)	Main Stem Flow (cfs)
Mar 12 86	2.66	225	4.43	6700
Mar 13 86	7.91	5440	4.98	8050
Mar 14 86	2.56	197	4.14	6040
Mar 15 86	2.51	183	4.01	5760
Mar 16 86	2.51	183	3.88	5480
Mar 17 86	10.25	9930	7.05	14420
Mar 18 86	10.22	9860	6.81	13580
Mar 19 86	2.52	185	3.56	4840
Mar 20 86	9.10	7530	4.87	7770
Mar 21 86	2.55	194	3.47	4660
Mar 22 86	2.58	202	3.53	4780
Mar 23 86	2.59	205	3.54	4800
Mar 24 86	10.25	9930	7.08	14530
Mar 25 86	7.45	4710	7.08	14530
Mar 26 86	2.69	234	3.70	5110
Mar 27 86	2.71	240	3.66	5030
Mar 28 86	2.73	246	4.29	6380
Mar 29 86	2.73	246	5.14	8470
Mar 30 86	2.67	228	6.07	11150
Mar 31 86	10.18	9780	8.83	21580
Apr 1 86	10.20	9820	8.53	20260
Apr 2 86	10.19	9800	8.21	18910
Apr 3 86	7.58	4910	6.69	13170
Apr 4 86	2.51	183	5.24	8740
Apr 5 86	2.52	185	5.05	8240
Apr 6 86	2.51	183	4.92	7900
Apr 7 86	2.51	183	4.84	7700
Apr 8 86	2.52	185	5.01	8130
Apr 9 86	2.52	185	5.44	9290
Apr 10 86	2.53	188	5.94	10750
Apr 11 86	2.54	191	5.99	10910
Apr 12 86	2.54	191	5.90	10630
Apr 13 86	2.55	194	5.61	9780
Apr 14 86	10.12	9640	7.74	17010
Apr 15 86	2.52	185	5.08	8320
Apr 16 86	10.09	9580	7.68	16770
Apr 17 86	2.51	183	4.84	7700
Apr 18 86	10.12	9640	7.51	16120
Apr 19 86	10.13	9670	7.50	16080
Apr 20 86	2.45	167	4.38	6580
Apr 21 86	10.09	9580	7.37	15590

Mo. Day Yr	South Fork Gauge (ft)	South Fork Flow (cfs)	Main Stem Gauge (ft)	Main Stem Flow (cfs)
Apr 22 86	10.10	9600	8.16	18700
Apr 23 86	10.14	9690	9.35	23970
Apr 24 86	10.09	9580	9.36	24020
Apr 25 86	10.11	9620	8.90	21890
Apr 26 86	7.58	4910	8.69	20960
Apr 27 86	10.06	9510	8.25	19070
Apr 28 86	10.13	9670	8.17	18740
Apr 29 86	10.14	9690	8.12	18530
Apr 30 86	10.08	9560	7.83	17360
May 1 86	10.07	9530	7.66	16700
May 2 86	10.10	9600	7.60	16460
May 3 86	7.57	4900	6.28	11810
May 4 86	2.66	225	7.13	14710
May 5 86	10.04	9470	9.56	24980
May 6 86	10.03	9450	9.29	23690
May 7 86	10.03	9450	9.02	22440
May 8 86	9.67	8680	8.18	18780
May 9 86	2.56	197	6.43	12300
May 10 86	2.58	202	6.32	11940
May 11 86	2.59	205	6.25	11720
May 12 86	10.00	9380	8.22	18950
May 13 86	10.05	9490	8.40	19700
May 14 86	10.05	9490	8.40	19700
May 15 86	10.05	9490	8.20	18860
May 16 86	9.98	9340	8.02	18120
May 17 86	2.44	164	5.41	9210
May 18 86	2.48	175	5.27	8820
May 19 86	10.03	9450	8.09	18410
May 20 86	10.04	9470	8.68	20910
May 21 86	10.03	9450	10.82	31500
May 22 86	10.03	9450	11.36	34560
May 23 86	10.04	9470	11.22	33750
May 24 86	10.00	9380	10.24	28400
May 25 86	10.01	9400	9.82	26260
May 26 86	10.00	9380	11.04	32730
May 27 86	10.09	9580	12.49	41470
May 28 86	7.58	4910	12.54	41790
May 29 86	2.92	306	12.34	40510
May 30 86	5.46	2040	12.50	41530
May 31 86	6.27	3030	12.50	41530

APPENDIX A

Daily maximum gauge height (ft) and discharge (cfs), South Fork and main stem Flathead River at Columbia Falls, March 12 - May 31, 1984-1987 (continued).

Mo. Day Yr	South Fork Gauge (ft)	South Fork Flow (cfs)	Main Stem Gauge (ft)	Main Stem Flow (cfs)
Mar 12 85	4.01	761	3.03	3860
Mar 13 85	4.03	772	3.18	4130
Mar 14 85	4.03	772	3.31	4360
Mar 15 85	2.96	320	2.99	3790
Mar 16 55	3.17	393	3.03	3860
Mar 17 85	3.31	445	3.02	3840
Mar 18 85	3.32	449	3.02	3840
Mar 19 85	3.31	445	3.00	3810
Mar 20 85	3.87	686	2.95	3730
Mar 21 85	3.88	691	3.01	3830
Mar 22 85	4.30	940	3.06	3910
Mar 23 85	4.30	940	3.05	3900
Mar 24 85	4.30	940	3.00	3810
Mar 25 85	4.30	940	2.96	3740
Mar 26 85	4.28	926	3.04	3880
Mar 27 85	7.76	5200	4.90	7850
Mar 28 85	4.74	1290	3.04	3880
Mar 29 85	5.26	1820	3.29	4320
Mar 30 85	5.01	1560	3.28	4310
Mar 31 85	5.00	1550	3.20	4160
Apr 1 85	5.06	1610	3.20	4160
Apr 2 85	4.79	1340	3.11	4000
Apr 3 85	4.79	1340	3.15	4070
Apr 4 85	4.43	1040	3.24	4230
Apr 5 85	4.00	756	3.42	4570
Apr 6 85	2.67	228	4.48	6820
Apr 7 85	2.67	228	4.87	7770
Apr 8 85	2.66	225	5.03	8180
Apr 9 85	2.67	228	5.05	8240
Apr 10 85	2.64	219	4.90	7850
Apr 11 85	2.71	240	4.91	7870
Apr 12 85	2.66	225	4.90	7850
Apr 13 85	2.66	225	4.71	7370
Apr 14 85	2.65	222	4.49	6840
Apr 15 85	2.64	219	4.63	7180
Apr 16 85	2.68	231	5.32	8960
Apr 17 85	2.73	246	6.54	12660
Apr 18 85	2.73	246	7.21	15000
Apr 19 85	2.71	240	7.11	14640
Apr 20 85	2.68	231	6.50	12530
Apr 21 85	2.97	323	6.00	10940

Mo. Day Yr	South Fork Gauge (ft)	South Fork Flow (cfs)	Main Stem Gauge (ft)	Main Stem Flow (cfs)
Apr 22 85	2.73	246	6.12	11310
Apr 23 85	2.77	258	6.44	12330
Apr 24 85	2.79	265	6.82	13610
Apr 25 85	2.81	271	7.38	15630
Apr 26 85	2.80	268	7.60	16400
Apr 27 85	3.09	364	7.73	16970
Apr 28 85	2.77	258	8.60	20560
Apr 29 85	7.60	4940	10.88	31840
Apr 30 85	7.62	4980	11.84	37410
May 1 85	2.92	306	11.88	37650
May 2 85	2.90	300	11.85	37470
May 3 85	2.84	281	10.80	31390
May 4 85	3.32	449	9.33	23880
May 5 85	2.73	246	8.37	19580
May 6 85	2.75	252	8.81	21490
May 7 85	2.78	262	9.28	23640
May 8 85	6.38	3180	10.03	27320
May 9 85	2.87	290	10.11	27720
May 10 85	2.87	290	10.45	29500
May 11 85	8.56	6540	10.61	30360
May 12 85	2.82	274	9.87	26510
May 13 85	8.93	7210	11.07	32900
May 14 85	8.88	7120	10.68	30740
May 15 85	8.92	7190	10.40	29240
May 16 85	8.92	7190	10.41	29290
May 17 85	2.81	271	8.95	22120
May 18 85	9.99	9360	9.88	26560
May 19 85	10.00	9380	9.78	26060
May 20 85	9.93	9230	9.24	23450
May 21 85	9.95	9270	8.89	21850
May 22 85	9.94	9250	8.58	20480
May 23 85	2.74	249	6.15	11400
May 24 85	2.73	246	5.82	10390
May 25 85	2.72	243	5.71	10070
May 26 85	2.73	246	5.90	10630
May 27 85	2.73	246	6.32	11940
May 28 85	2.72	243	6.59	12830
May 29 85	2.72	243	6.59	12830
May 30 85	2.75	252	6.37	12100
May 31 85	2.75	252	6.83	13650

APPENDIX B

Flahtead Lake elevation (in feet) measured at Kerr Dam, March-June, 1984-1987.

Mo. Day	1984	1985	1986	1987
Mar 1	2884.8	2884.2	**2884.9**	2883.4
Mar 2	2884.8	2884.1	**2884.9**	2883.5
Mar 3	2884.9	2884.1	2884.9	2883.5
Mar 4	2884.9	2884.1	2884.8	2883.5
Mar 5	2884.9	2884.0	2884.8	2883.5
Mar 6	2884.9	2884.0	2884.8	2883.5
Mar 7	2884.9	2884.0	2884.8	2883.6
Mar 8	2884.8	2884.0	2884.8	2883.5
Mar 9	2884.7	2884.0	2884.9	2883.5
Mar 10	2884.7	2883.9	2884.8	2883.5
Mar 11	2884.6	2883.9	2884.9	2883.5
Mar 12	2884.4	2884.0	2884.9	2883.5
Mar 13	2884.5	2884.0	2884.9	2883.5
Mar 14	2884.5	2884.0	2884.8	2883.5
Mar 15	2884.4	2883.9	2884.8	2883.5
Mar 16	2884.4	2883.9	2884.8	2883.6
Mar 17	2884.3	2883.9	2884.8	2883.6
Mar 18	2884.3	2883.9	2884.8	2883.6
Mar 19	2884.2	2883.9	2884.8	2883.6
Mar 20	2884.2	2883.9	2884.8	2883.7
Mar 21	2884.2	2883.8	2884.8	2883.7
Mar 22	2884.2	2883.8	2884.8	2883.6
Mar 23	2884.1	2883.8	2884.7	2883.6
Mar 24	2884.1	2883.8	2884.7	2883.6
Mar 25	2884.2	2883.8	2884.7	2883.6
Mar 26	2884.1	2883.7	2884.7	2883.6
Mar 27	2884.1	2883.7	2884.7	2883.6
Mar 28	2884.0	2883.7	2884.7	2883.6
Mar 29	2884.1	2883.7	2884.7	2883.6
Mar 30	2884.0	2883.7	2884.7	2883.6
Mar 31	2884.0	2883.6	2884.9	2883.5
Apr 1	2883.9	2883.6	2885.1	2883.5
Apr 2	2883.9	2883.6	2885.2	2883.5
Apr 3	2883.8	2883.5	2885.3	2883.5
Apr 4	2883.8	2883.5	2885.3	2883.5
Apr 5	2883.8	2883.5	2885.3	2883.5
Apr 6	2883.8	2883.5	2885.3	2883.6
Apr 7	2883.9	2883.5	2885.3	2883.6
Apr 8	2883.8	2883.5	2885.3	2883.7
Apr 9	2883.8	2883.6	2885.4	2883.7
Apr 10	2883.8	2883.5	2885.4	2883.8
Apr 11	2883.8	2883.5	2885.4	2883.8
Apr 12	2883.8	2883.7	2885.3	2883.9

APPENDIX B

Flahtead Lake elevation (in feet) measured at Kerr Dam, March-June, 1984-1987 (continued).

Mo. Day	1984	1985	1986	1987
Apr 13	2883.8	2883.7	2885.3	2883.9
Apr 14	2883.8	2884.1	2885.3	2884.0
Apr 15	2883.8	2884.1	2885.3	2884.0
Apr 16	2883.8	2884.5	2885.3	2884.1
Apr 17	2883.8	2884.6	2885.3	2884.2
Apr 18	2883.8	2884.8	2885.4	2884.3
Apr 19	2884.0	2884.9	2885.3	2884.4
Apr 20	2884.2	2884.9	2885.3	2884.4
Apr 21	2884.3	2885.1	2885.2	2884.5
Apr 22	2884.4	2885.2	2885.2	2884.7
Apr 23	2884.5	2885.1	2885.3	2884.7
Apr 24	2884.7	2885.2	2885.5	2884.8
Apr 25	2885.0	2885.3	2885.6	2884.8
Apr 26	2884.9	2885.2	2885.7	2885.0
Apr 27	2884.8	2885.2	2885.7	2885.1
Apr 28	2884.8	2885.2	2885.8	2885.3
Apr 29	2884.8	2885.2	2886.0	2885.5
Apr 30	2884.8	2885.2	2886.1	2885.8
May 1	2884.9	2885.3	2886.1	2886.4
May 2	2885.0	2885.3	2886.1	2887.0
May 3	2885.1	2885.6	2886.2	2887.4
May 4	2885.2	2885.9	2886.2	2887.7
May 5	2885.2	2886.3	2886.4	2887.9
May 6	2885.2	2886.5	2886.5	2888.1
May 7	2885.1	2886.7	2886.6	2888.4
May 8	2885.1	2886.8	2886.7	2888.6
May 9	2885.0	2886.9	2886.8	2888.9
May 10	2885.1	2887.0	2886.9	2889.1
May 11	2885.1	2887.1	2887.0	2889.4
May 12	2885.1	2887.2	2887.0	2889.7
May 13	2885.1	2887.4	2887.1	2890.1
May 14	2885.1	2887.4	2887.3	2890.3
May 15	2885.3	2887.5	2887.4	2890.6
May 16	2885.6	2887.6	2887.5	2890.8
May 17	2885.8	2887.7	2887.6	2890.3
May 18	2886.2	2887.9	2887.6	2890.8
May 19	2886.4	2888.1	2887.7	2891.0
May 20	2886.7	2888.4	2888.0	2890.9
May 21	2887.1	2888.8	2888.3	2890.9
May 22	2887.4	2889.2	2888.7	2891.0
May 23	2887.7	2889.6	2889.1	2891.0
May 24	2888.0	2890.1	2889.4	2891.0
May 25	2888.3	2890.5	2889.6	2891.0
May 26	2888.6	2890.8	2889.9	2891.1

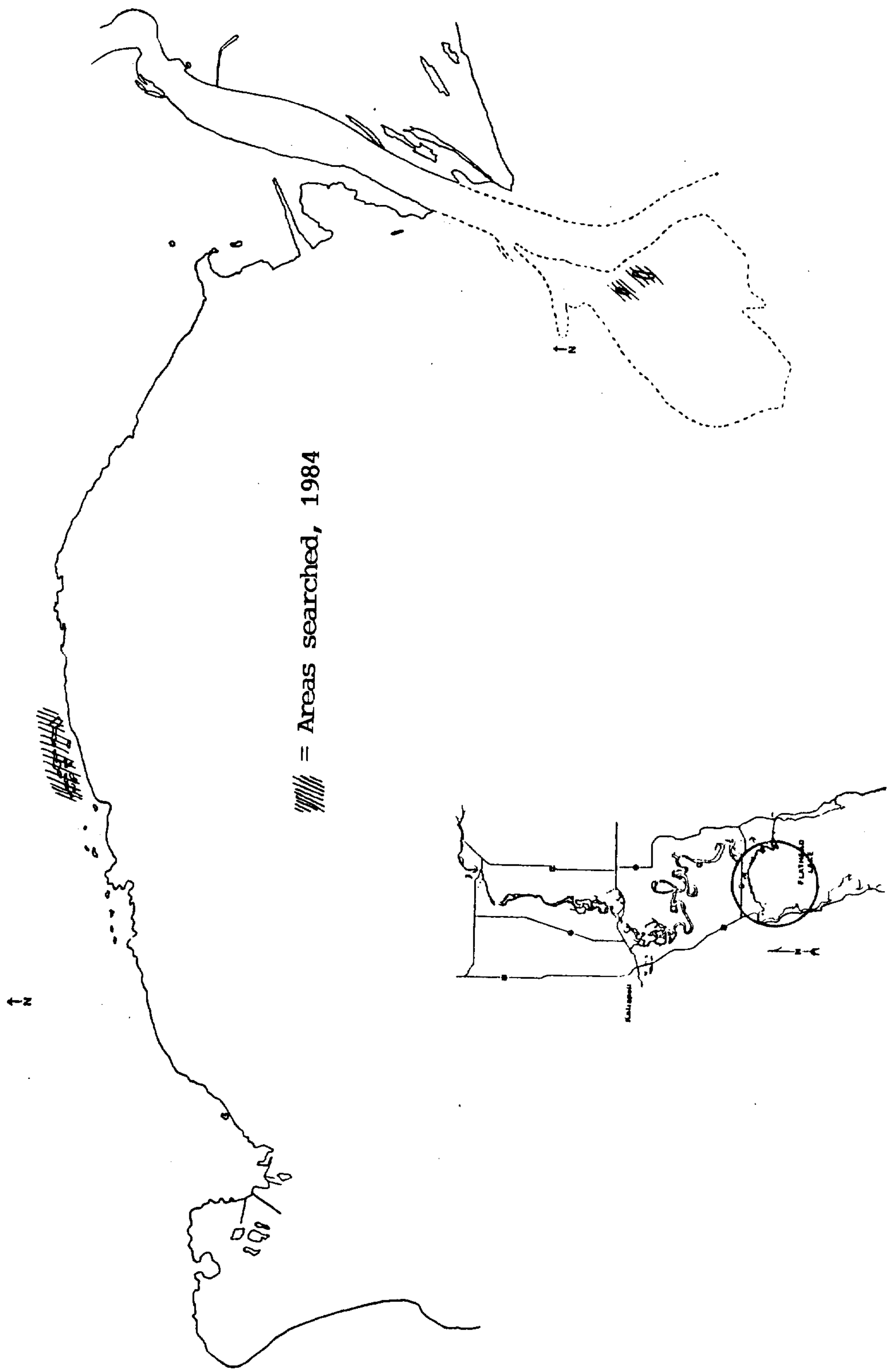
ABBENDIX B

Flathead Lake elevation (in feet) measured at Kerr Dam, March-June, 1984-1987 (continued).

Mo. Day	1984	1985	1986	1987
May 27	2888.9	2890.9	2890.2	2891.1
May 28	2889.2	2891.1	2890.5	2891.2
May 29	2889.5	2891.1	2890.7	2891.2
May 30	2889.8	2891.2	2890.9	2891.3
May 31	2890.3	2891.2	2891.4	2891.3
Jun 1	2890.7	2891.3	2891.4	2891.4
Jun 2	2890.9	2891.5	2891.5	2891.5
Jun 3	2891.1	2891.6	2891.7	2891.6
Jun 4	2891.2	2891.7	2891.9	2891.7
Jun 5	2891.4	2891.8	2891.9	2891.8
Jun 6	2891.5	2891.9	2892.0	2891.9
Jun 7	2891.7	2892.0	2892.0	2892.0
Jun 8	2891.8	2892.2	2892.1	2892.1
Jun 9	2892.0	2892.4	2892.2	2892.3
Jun 10	2891.9	2892.5	2892.3	2892.4
Jun 11	2891.9	2892.5	2892.4	2892.5
Jun 12	2892.0	2892.4	2892.6	2892.6
Jun 13	2892.0	2892.5	2892.7	2892.7
Jun 14	2892.0	2892.4	2892.7	2892.8
Jun 15	2892.0	2892.4	2892.7	2892.9
Jun 16	2892.0	2892.4	2892.8	2893.0
Jun 17	2892.1	2892.4	2892.8	2893.0
Jun 18	2892.1	2892.4	2892.7	2893.0
Jun 19	2892.2	2892.4	2892.7	2893.0
Jun 20	2892.3	2892.7	2892.6	2893.0
Jun 21	2892.5	2892.7	2892.7	2893.0
Jun 22	2892.5	2892.8	2892.6	2893.0
Jun 23	2892.5	2892.8	2892.6	2893.0
Jun 24	2892.5	2892.9	2892.7	2893.0
Jun 25	2892.7	2892.8	2892.8	2893.0
Jun 26	2892.9	2892.9	2892.7	2893.0
Jun 27	2893.0	2892.9	2892.8	2893.0
Jun 28	2892.9	2892.9	2892.8	2893.0
Jun 29	2892.8	2892.9	2892.8	2893.0
Jun 30	2892.8	2892.9	2892.7	2893.0

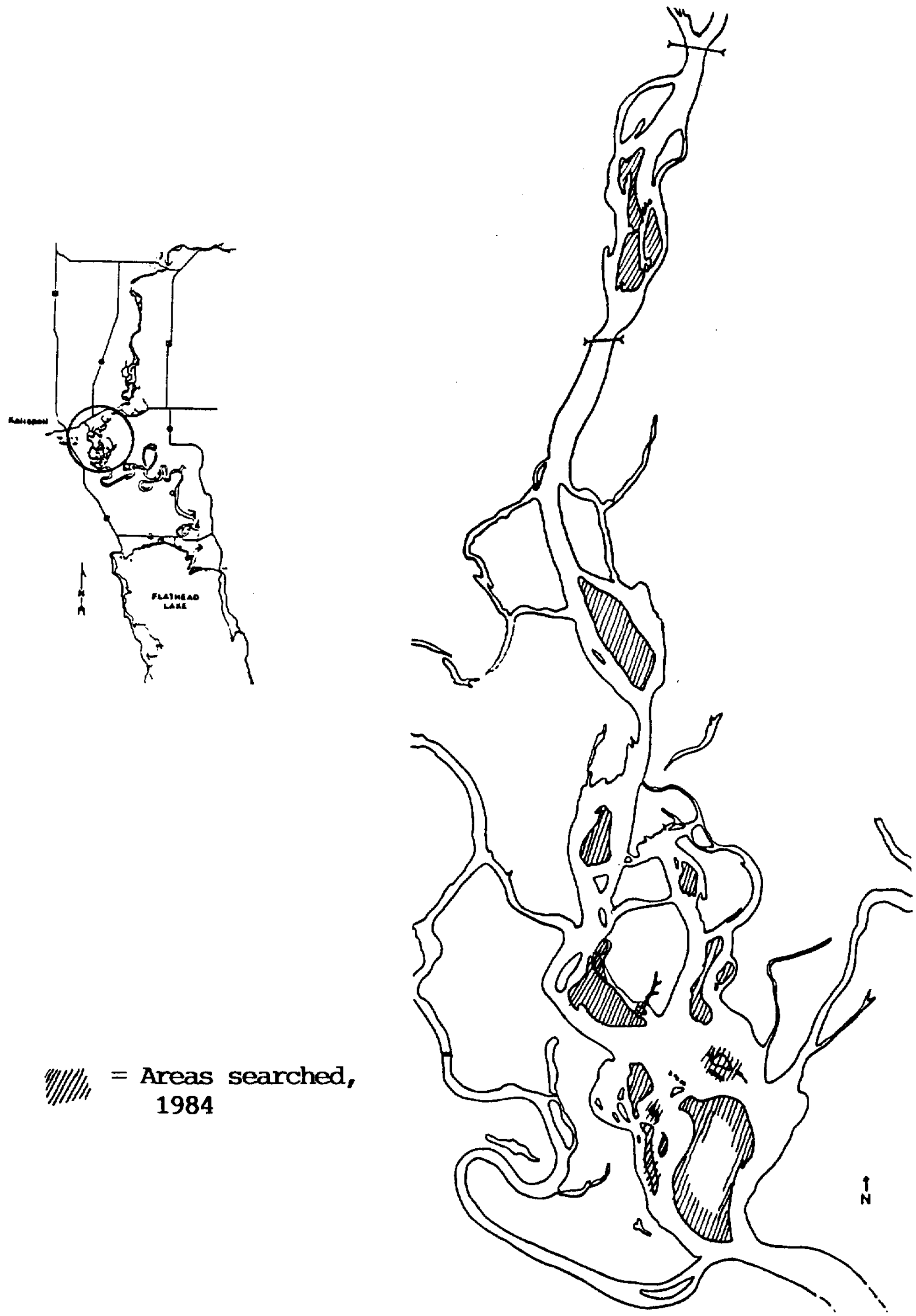
APPENDIX C

Areas searched for Canada goose ground nests, northern Flatehad Valley, Montana, 1984-1987.



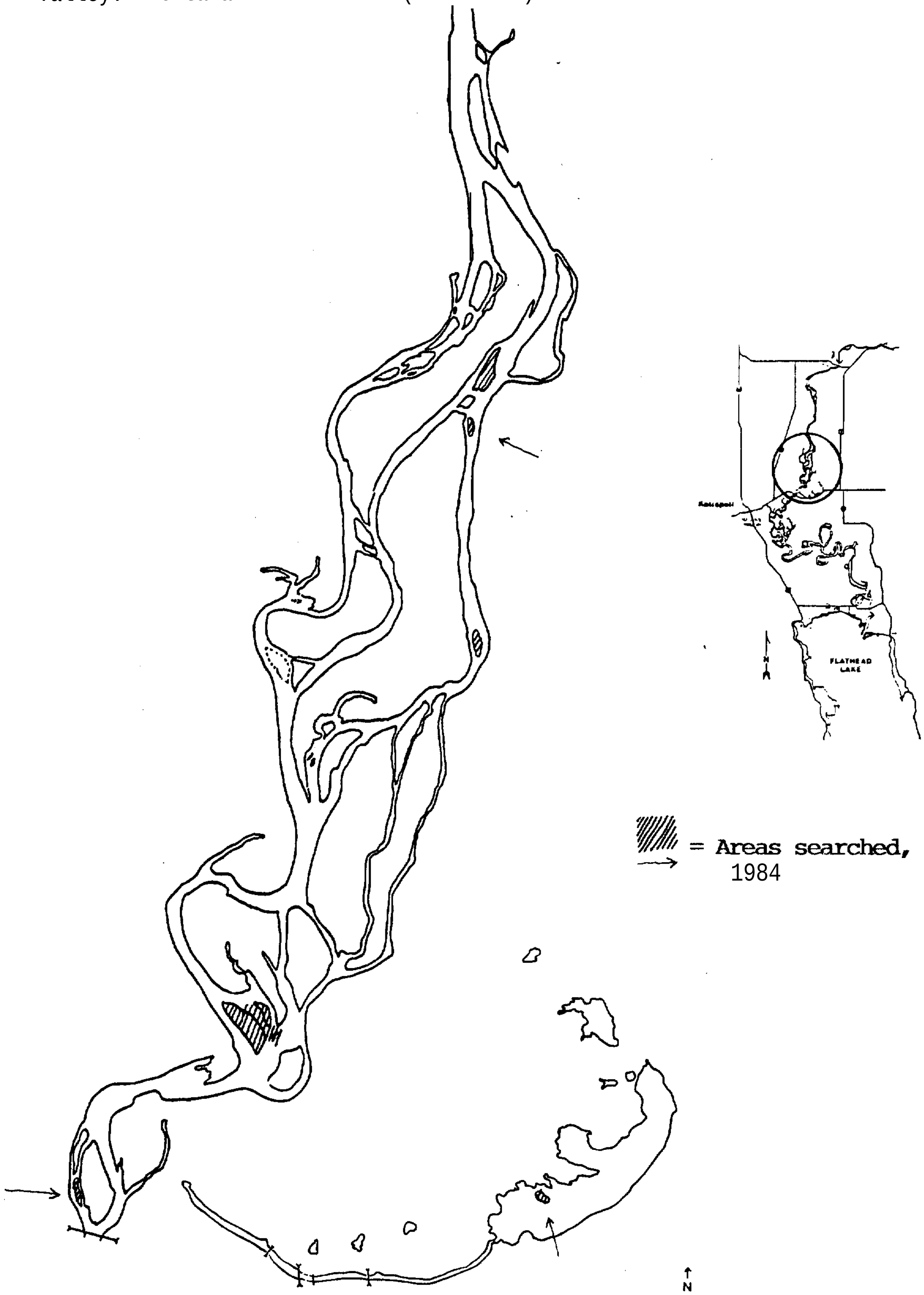
APPENDIX C

Areas searched for Canada goose ground nests, northern Flathead Valley, Montana, 1984-1987 (continued).



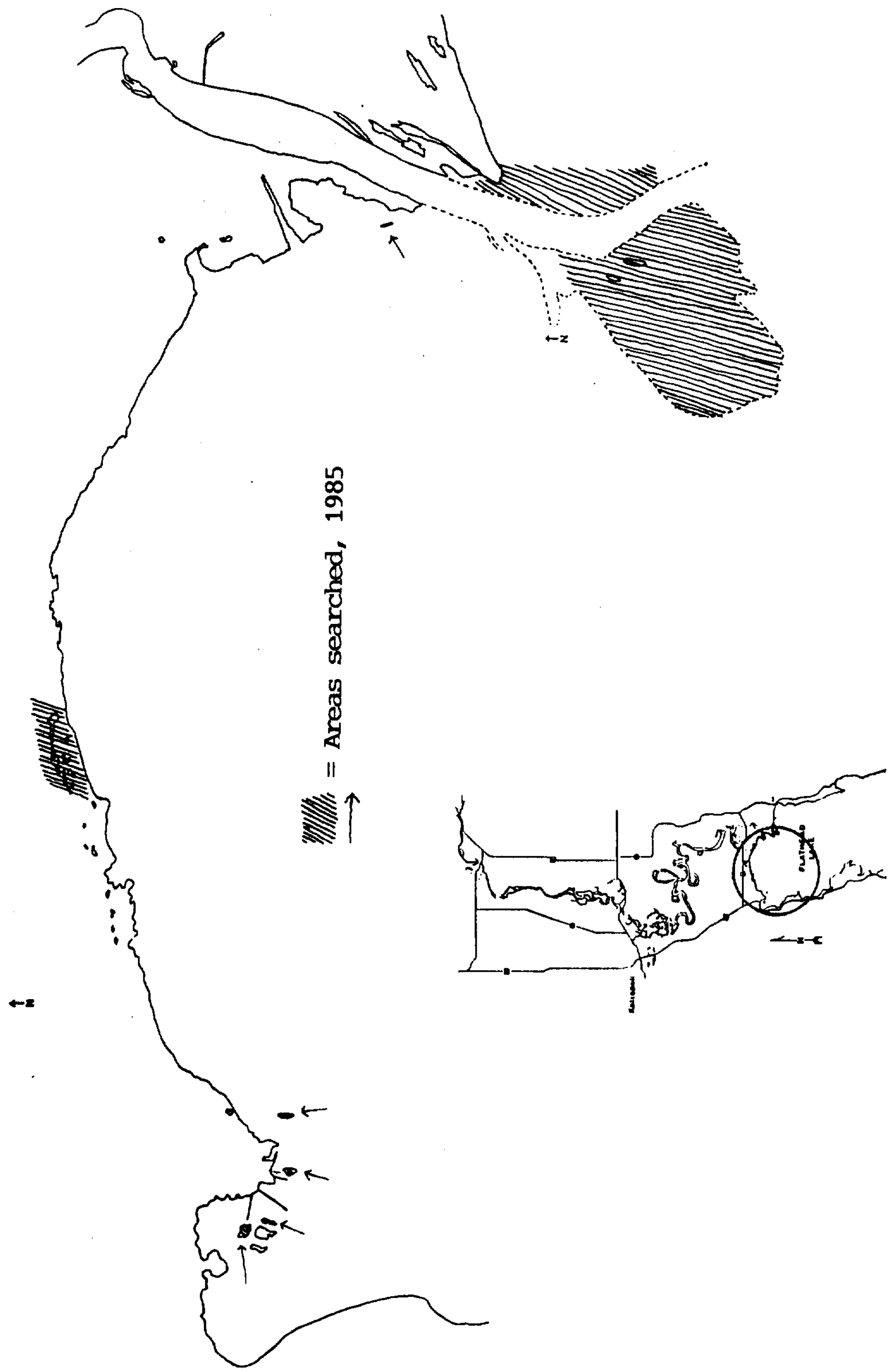
APPENDIX C

Areas searched for Canada goose groundnests, northern Flathead Valley. Montana. 1984-1987 (continued).



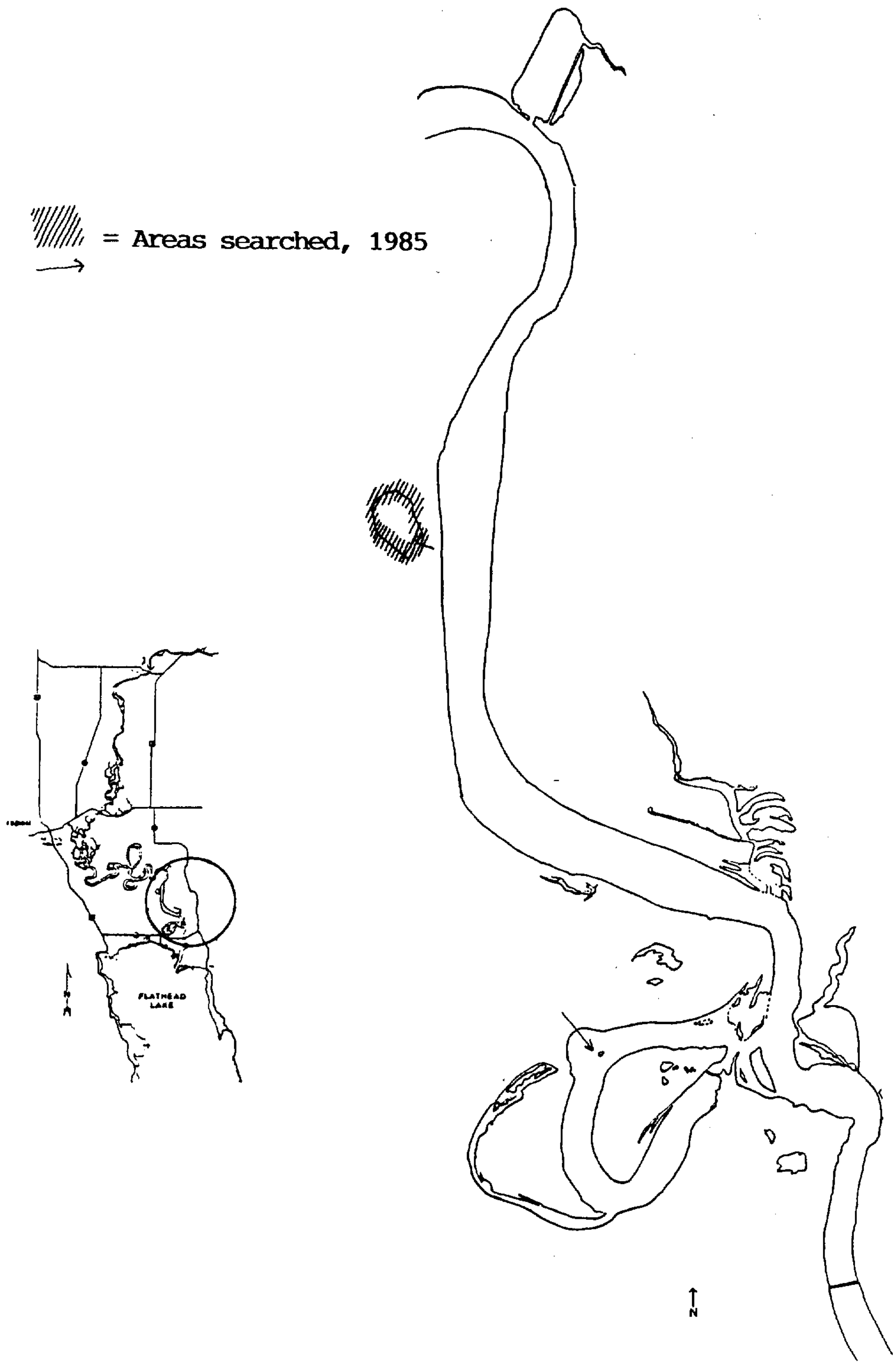
APPENDIX C

Areas searched for Canada goose groundnests, northern Flathead Valley, Montana, 1984-1987 (continued).



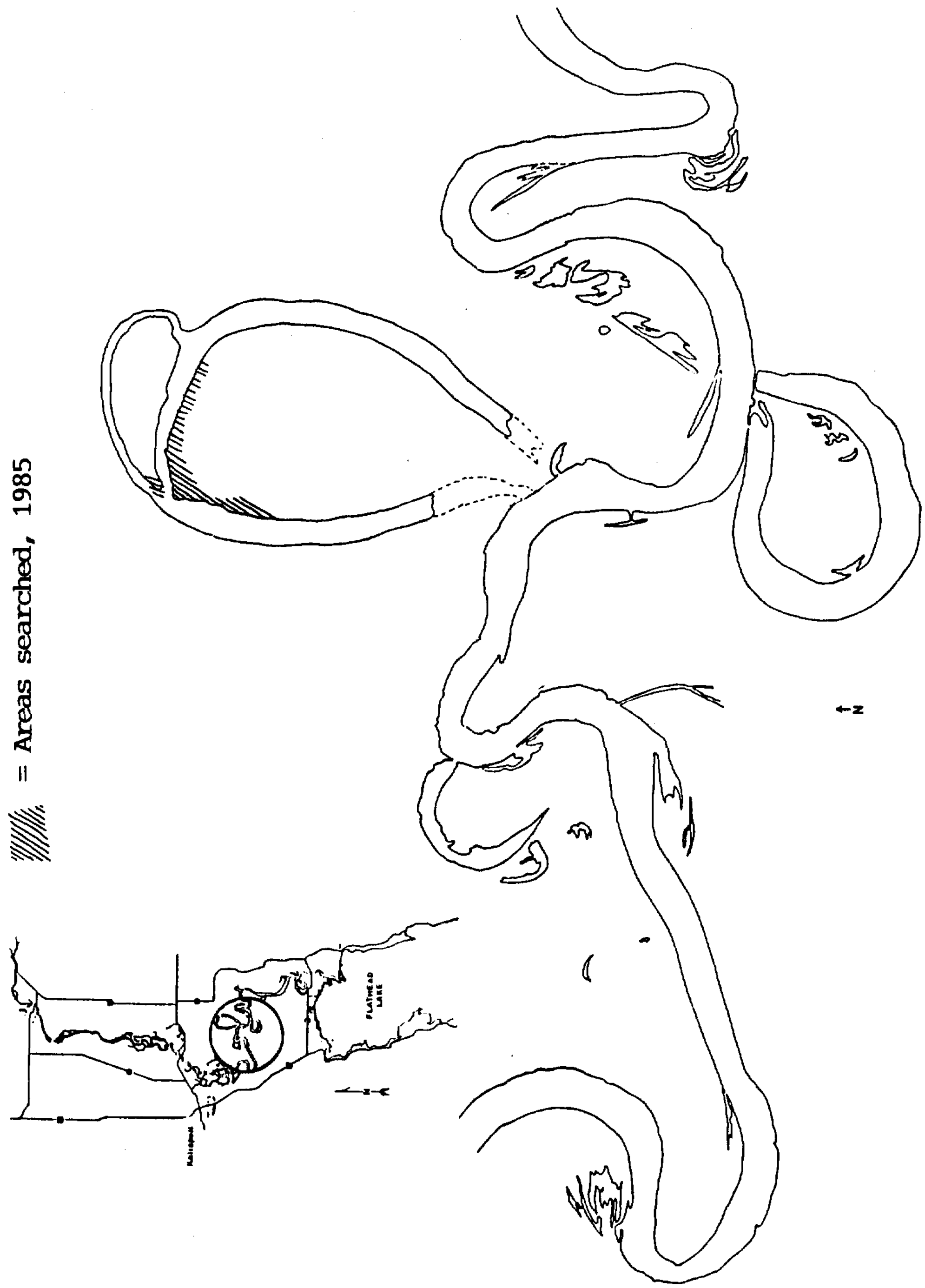
APPENDIX C

Areas searched for Canada goose ground nests, northern Flathead Valley, Montana, 1984-1987 (continued).



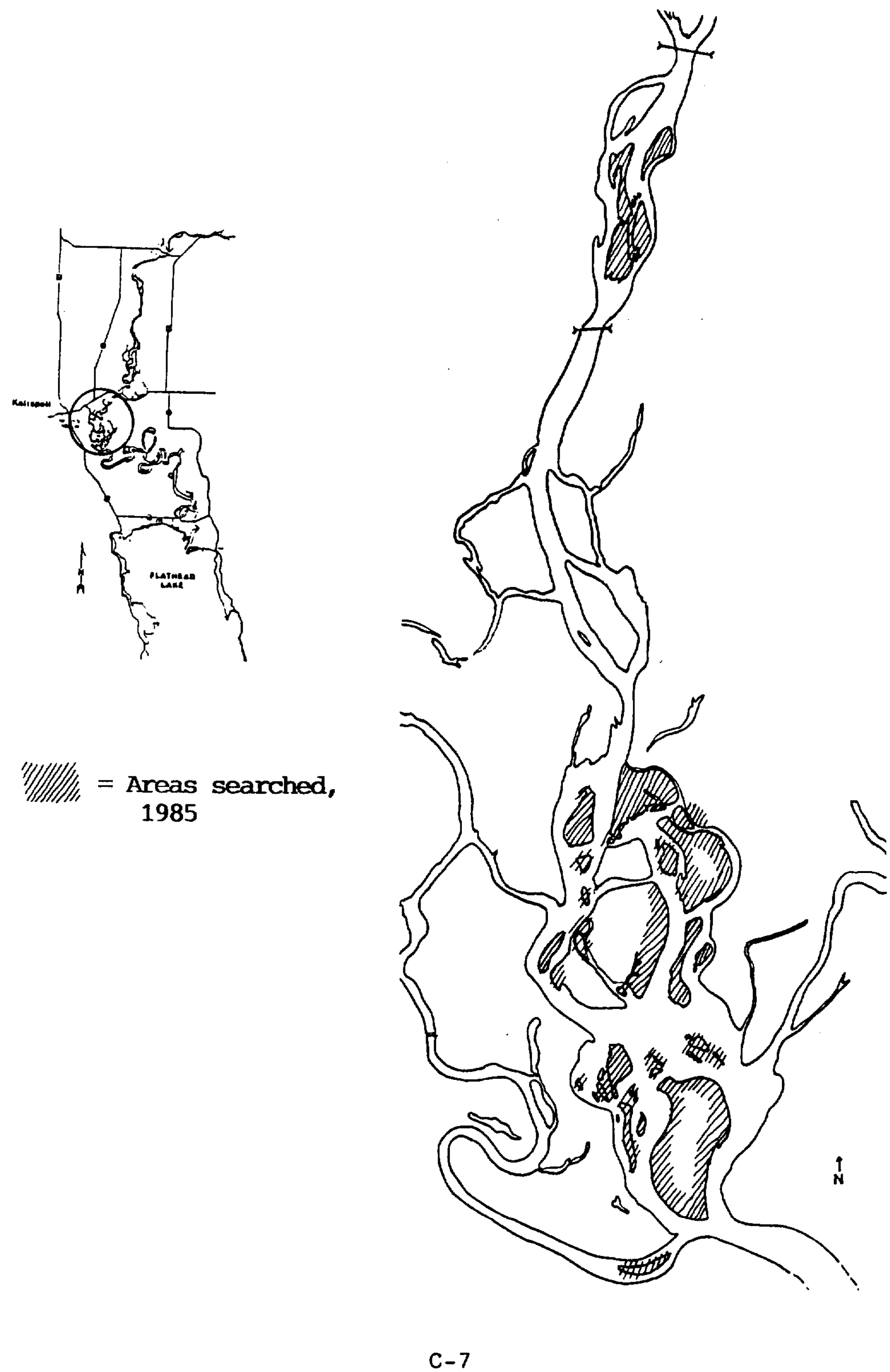
APPENDIX C

Areas searched for Canada goose groundnests, northern Flathead Valley, Montana, 1984-1987 (continued).



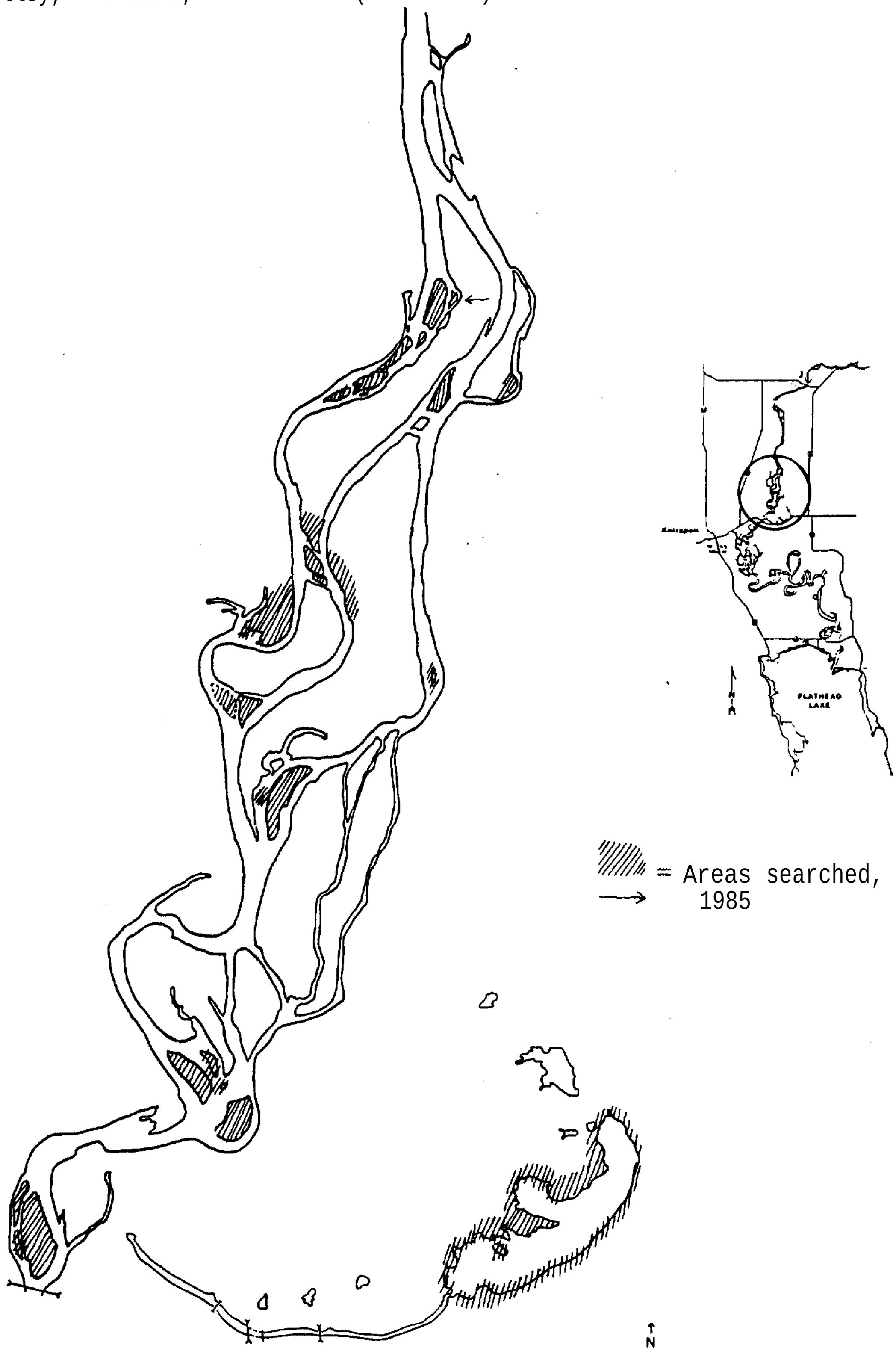
APPENDIX C

Areas searched for Canada goose ground nests, northern Flathead Valley, Montana, 1984-1987 (continued).



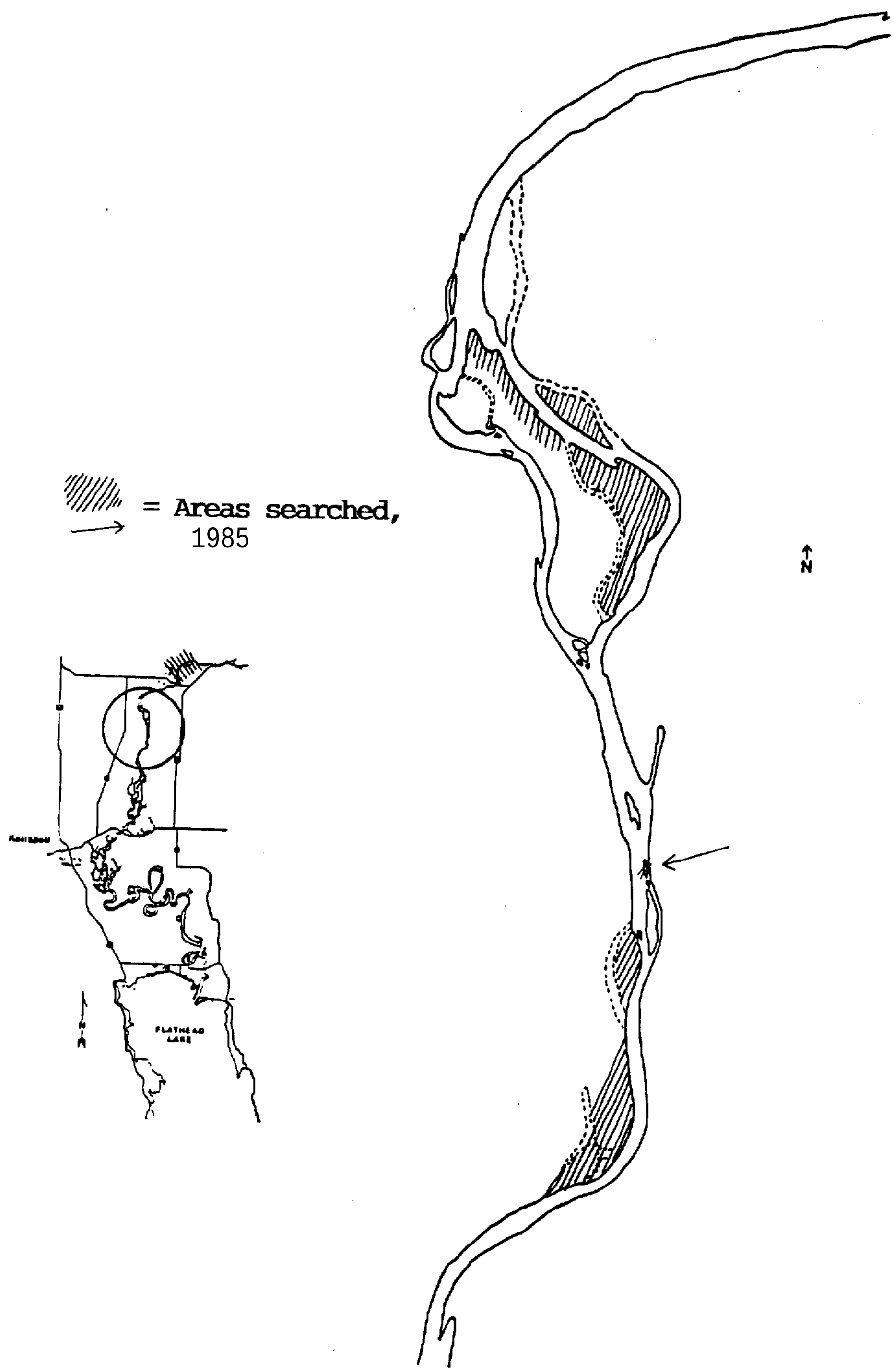
APENDIX C

Areas searched for Canada goose groundnests, northern Flathead Valley, Montana, 1984-1987 (continued).



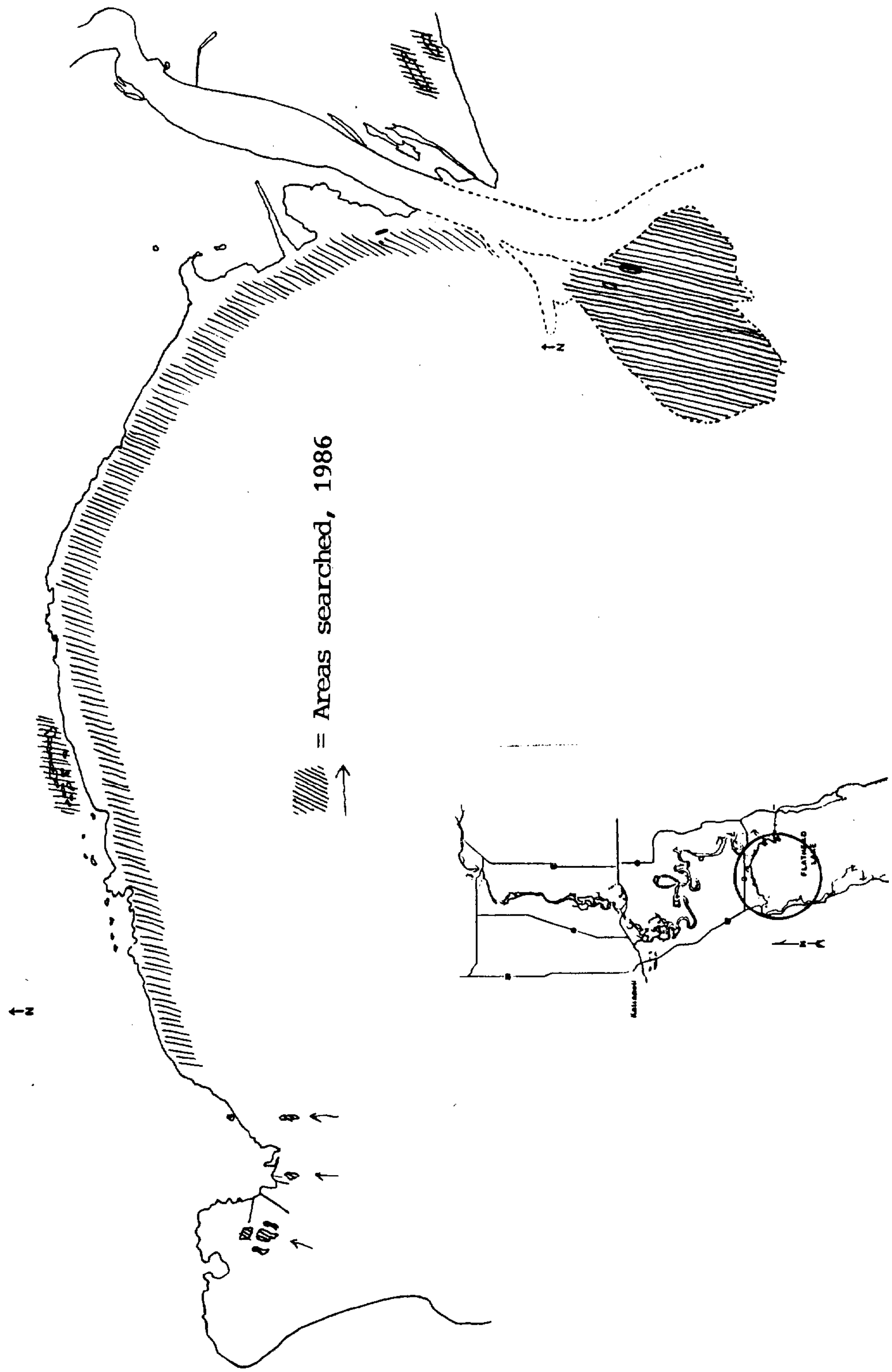
APPENDIX C

Areas searched for Canada goose groundnests, northern Flathead Valley, Montana, 1984-1987 (continued).



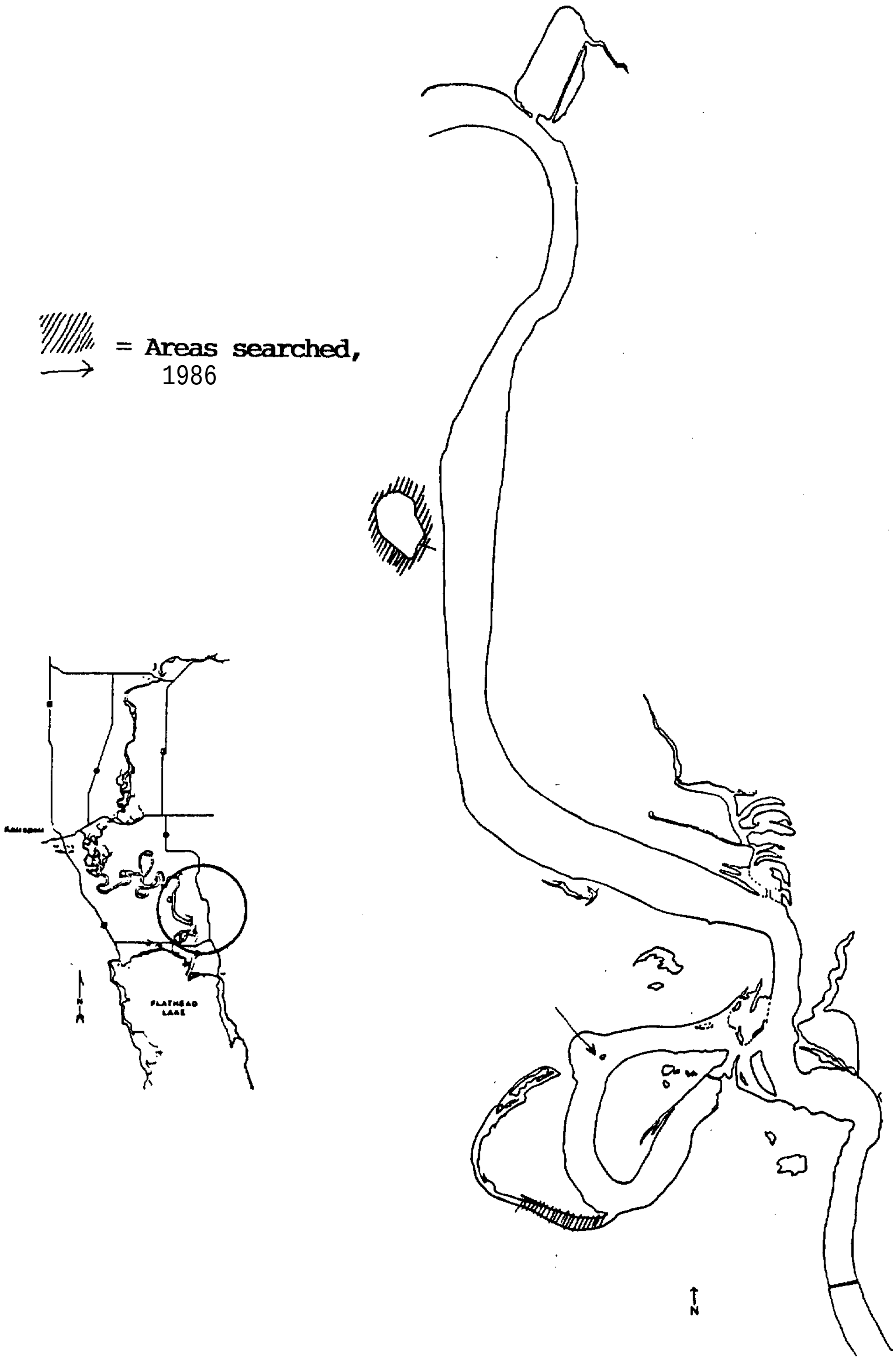
APPENDIX C

Areas searched for Canada goose ground nests, northern Flathead Valley, Montana, 1984-1987 (continued).



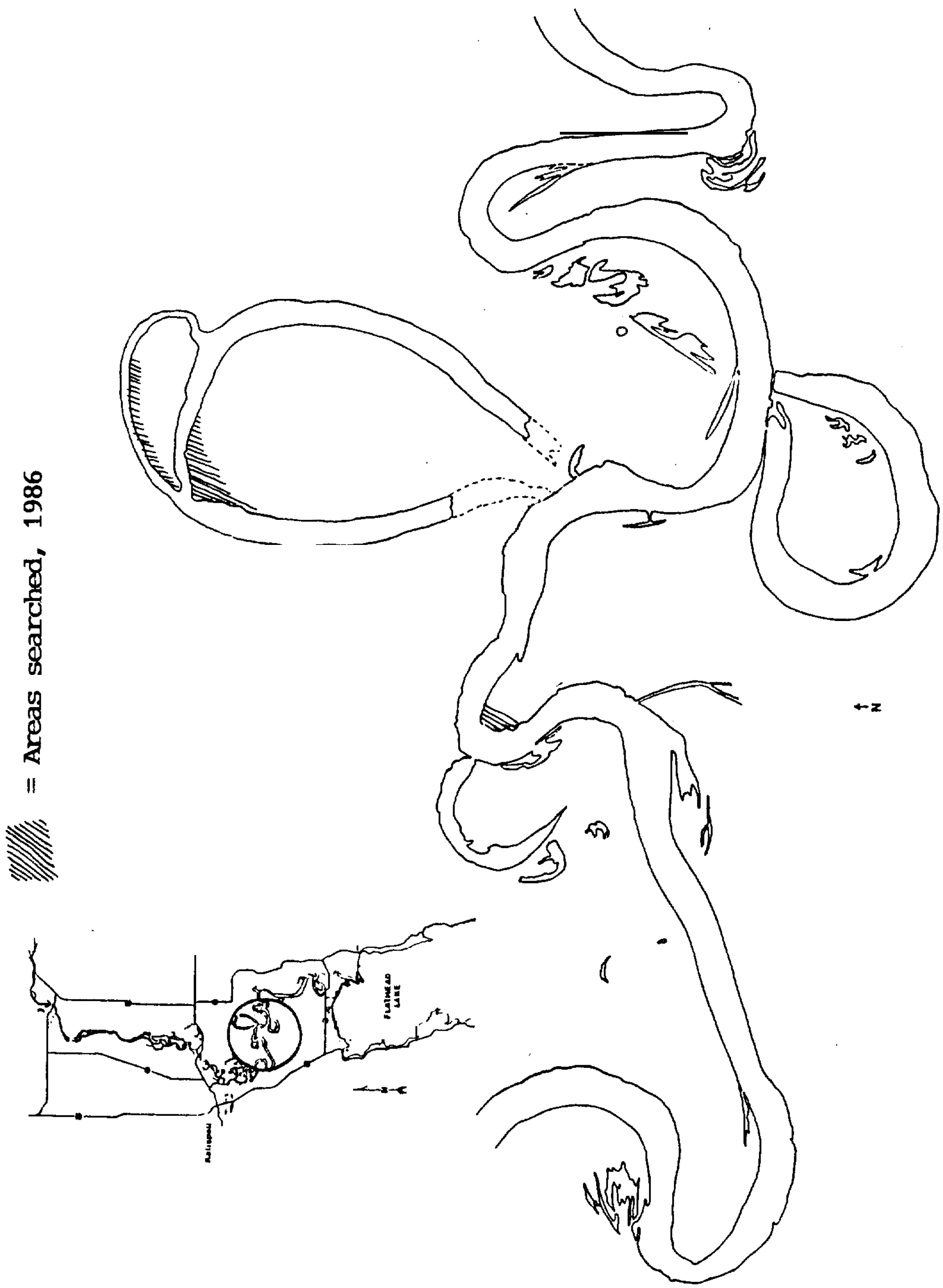
APPENDIX C

Areas searched for Canada goose ground nests, northern Flathead Valley, Montana, 1984-1987 (continued).



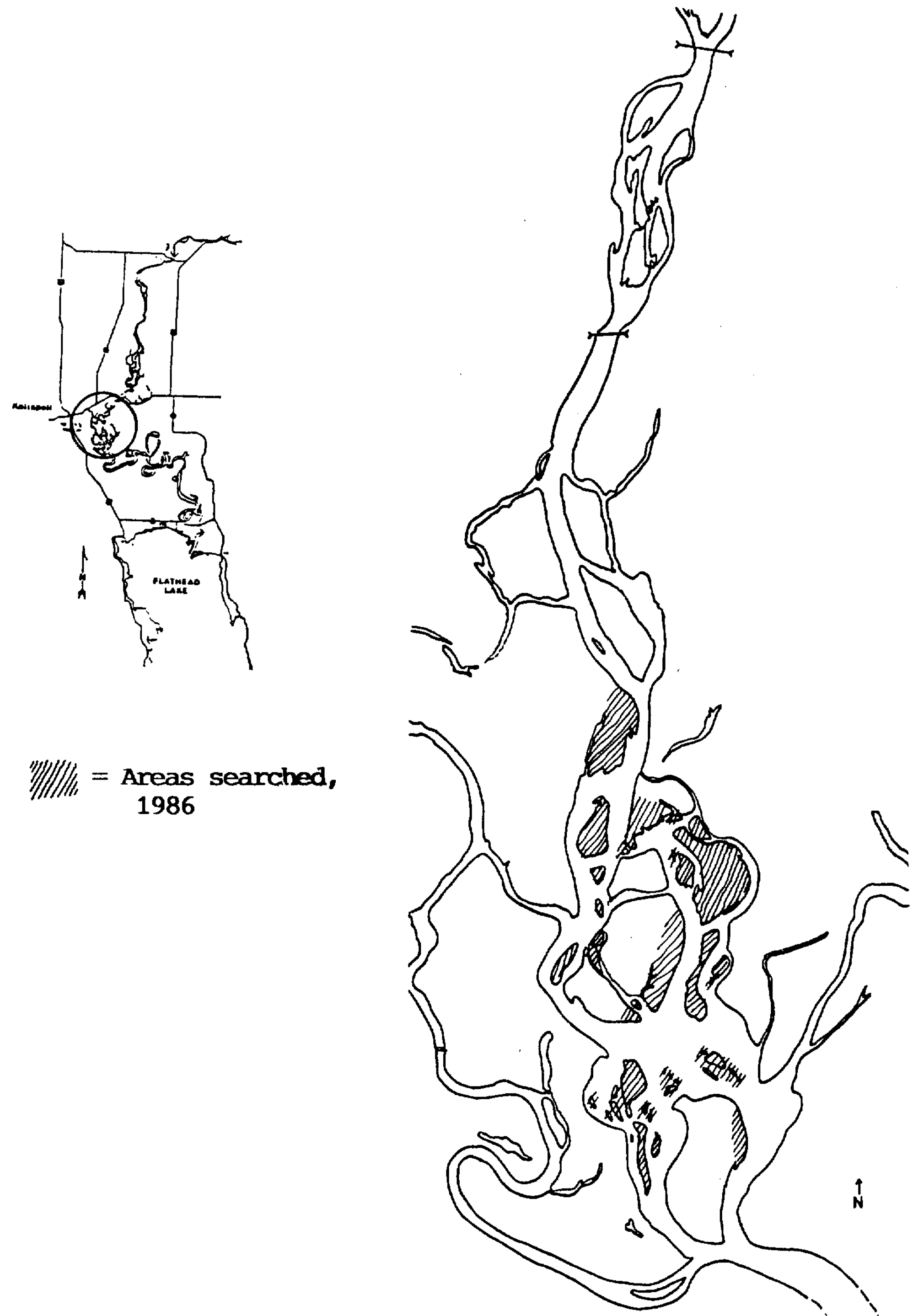
APPENDIX C

Areas searched for Canada goose groundnests, northern Flathead Valley, Montana, 1984-1987 (continued).



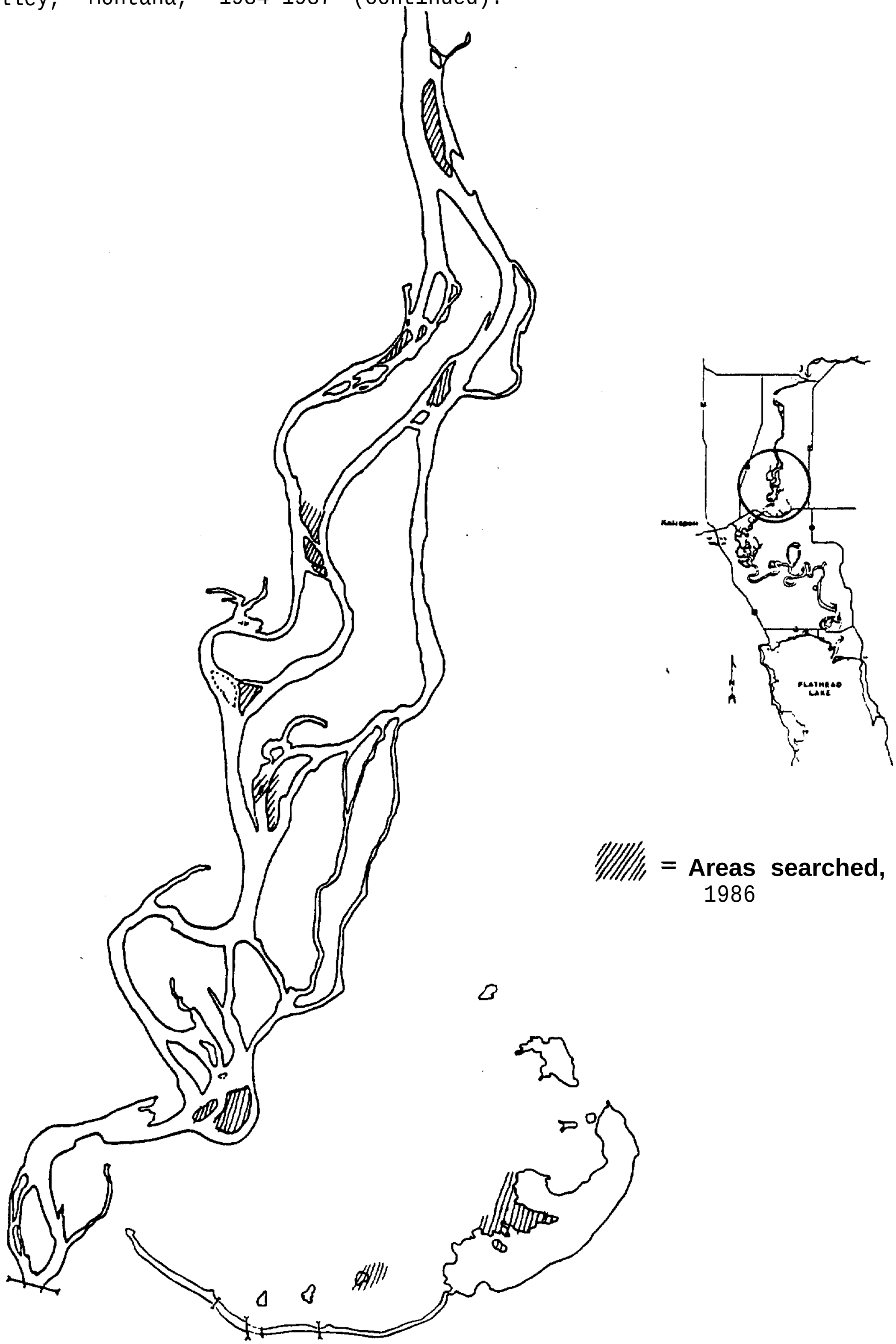
APPENDIX c

Areas searched for Canada goose groundnests, northern Flathead Valley, Montana, 1984-1987 (continued).



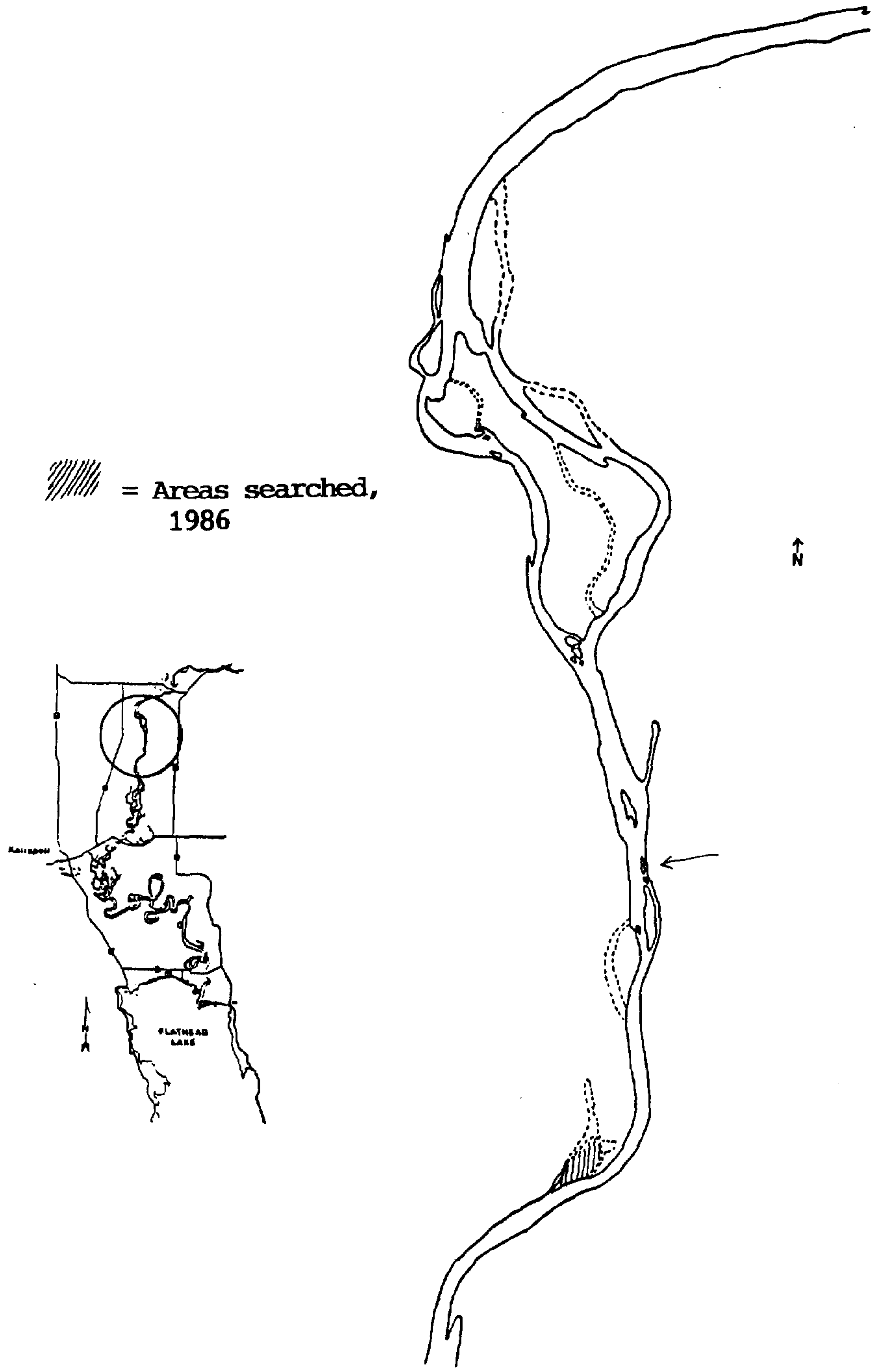
APPENDIX C

Areas searched for Canada goose groundnests, northern Flathead Valley, Montana, 1984-1987 (continued).



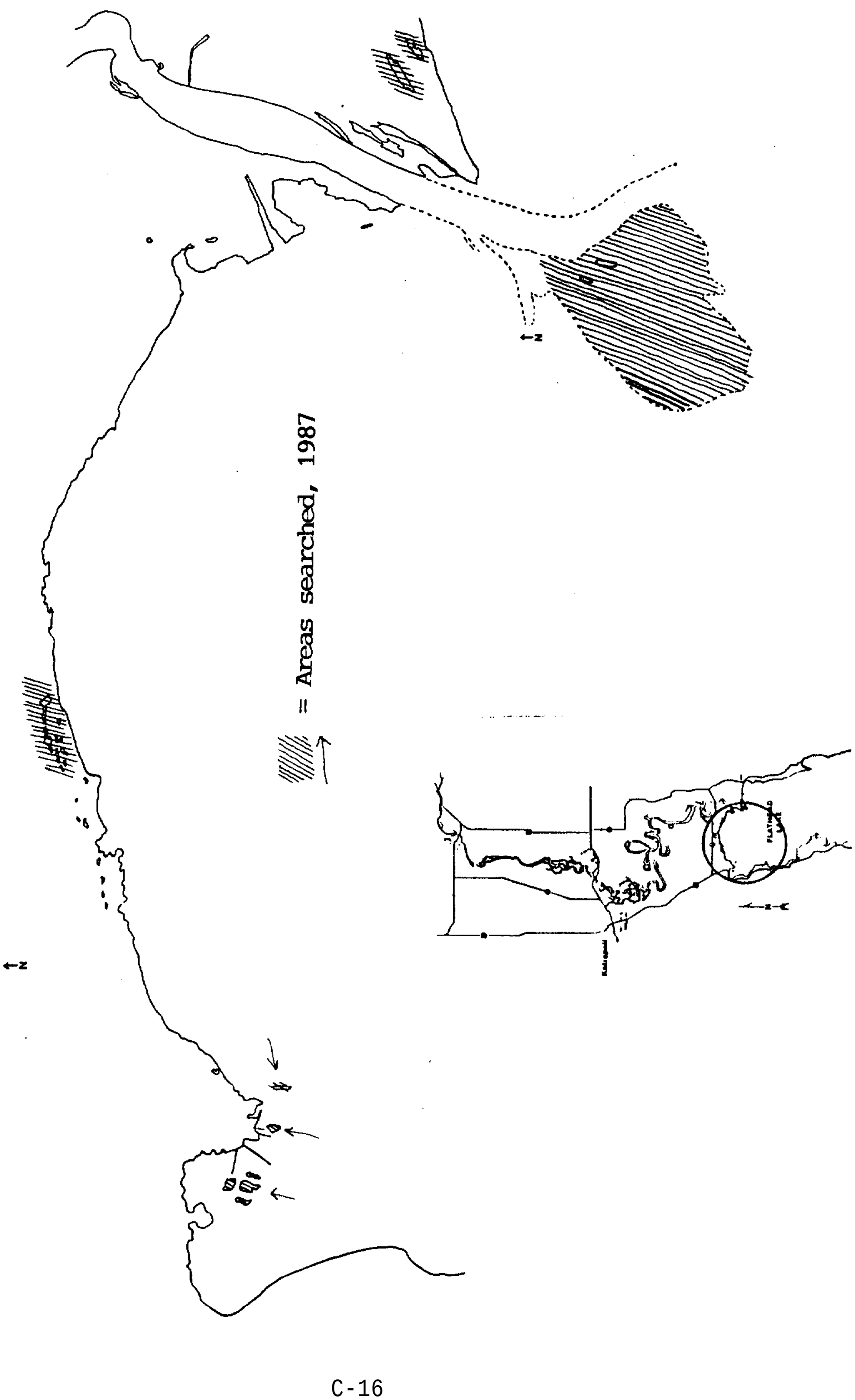
APPENDIX C

Areas searched for Canada goose ground nests, northern Flathead Valley, Montana, 1984-1987 (continued).



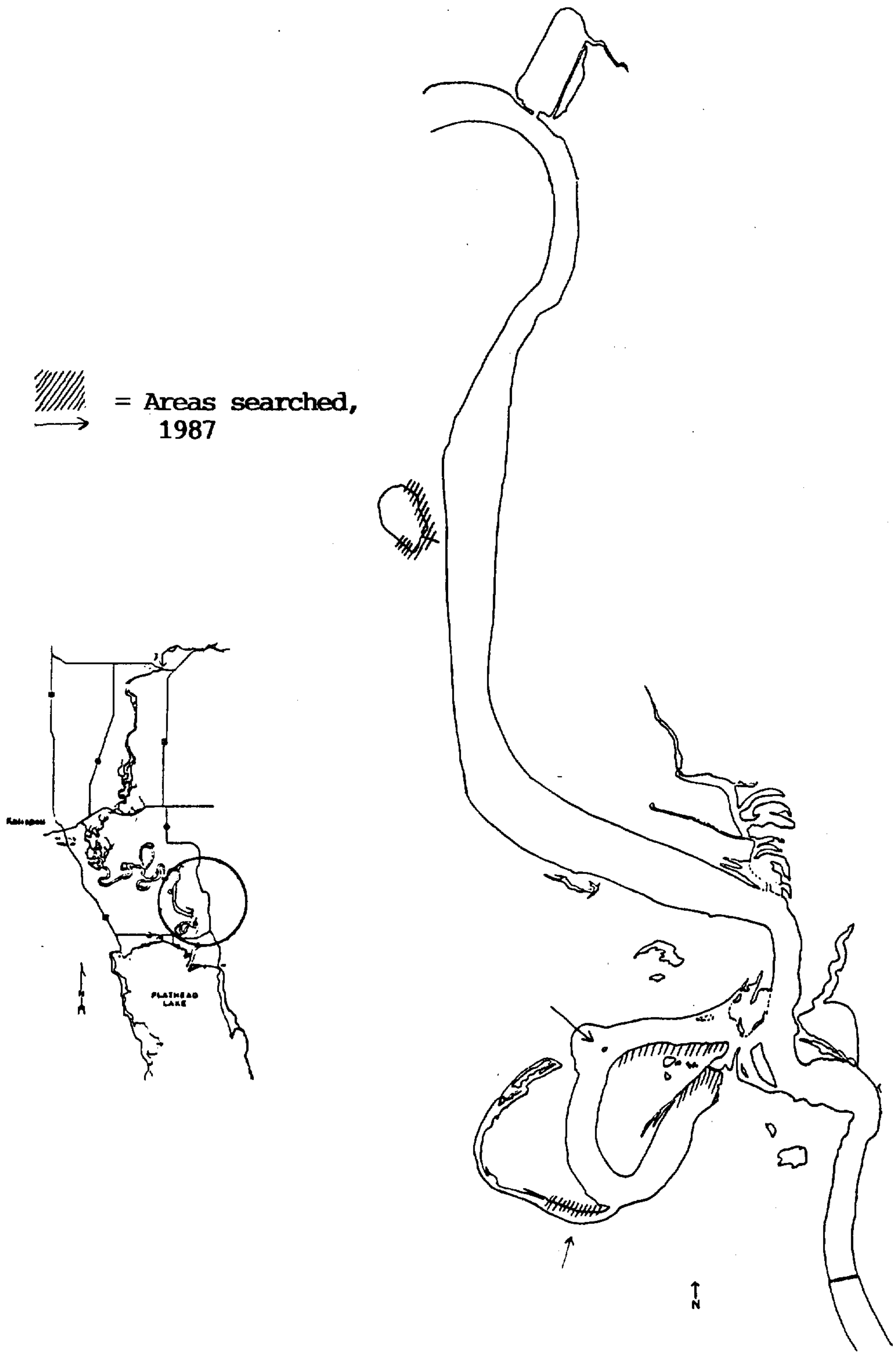
APPENDIX C

Areas searched for Canada goose groundnests, northern Flathead Valley, Montana, 1984-1987 (continued).



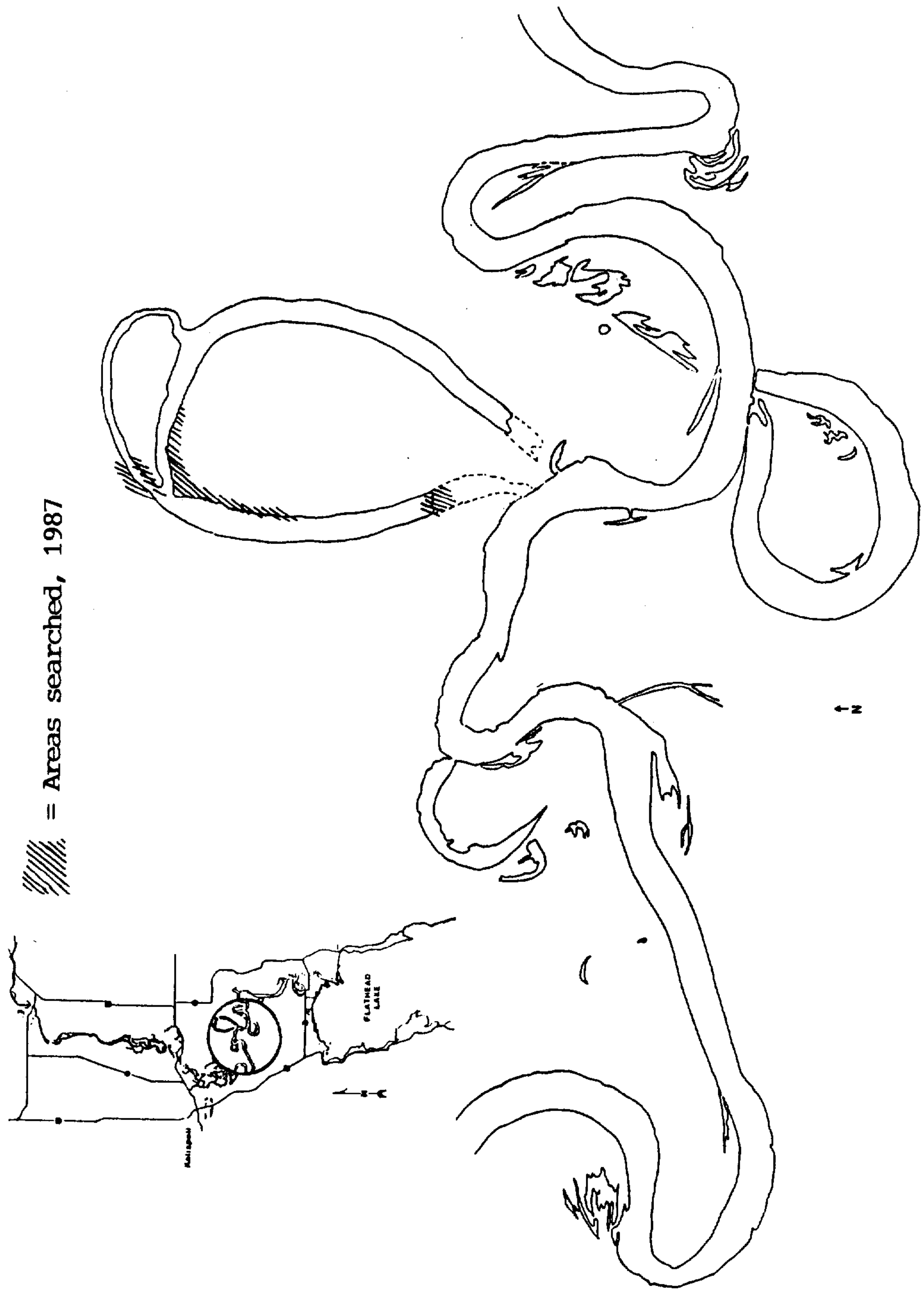
APPENDIX C

Areas searched for Canada goose groundnests, northern Flathead Valley, Montana, 1984-1987 (continued).



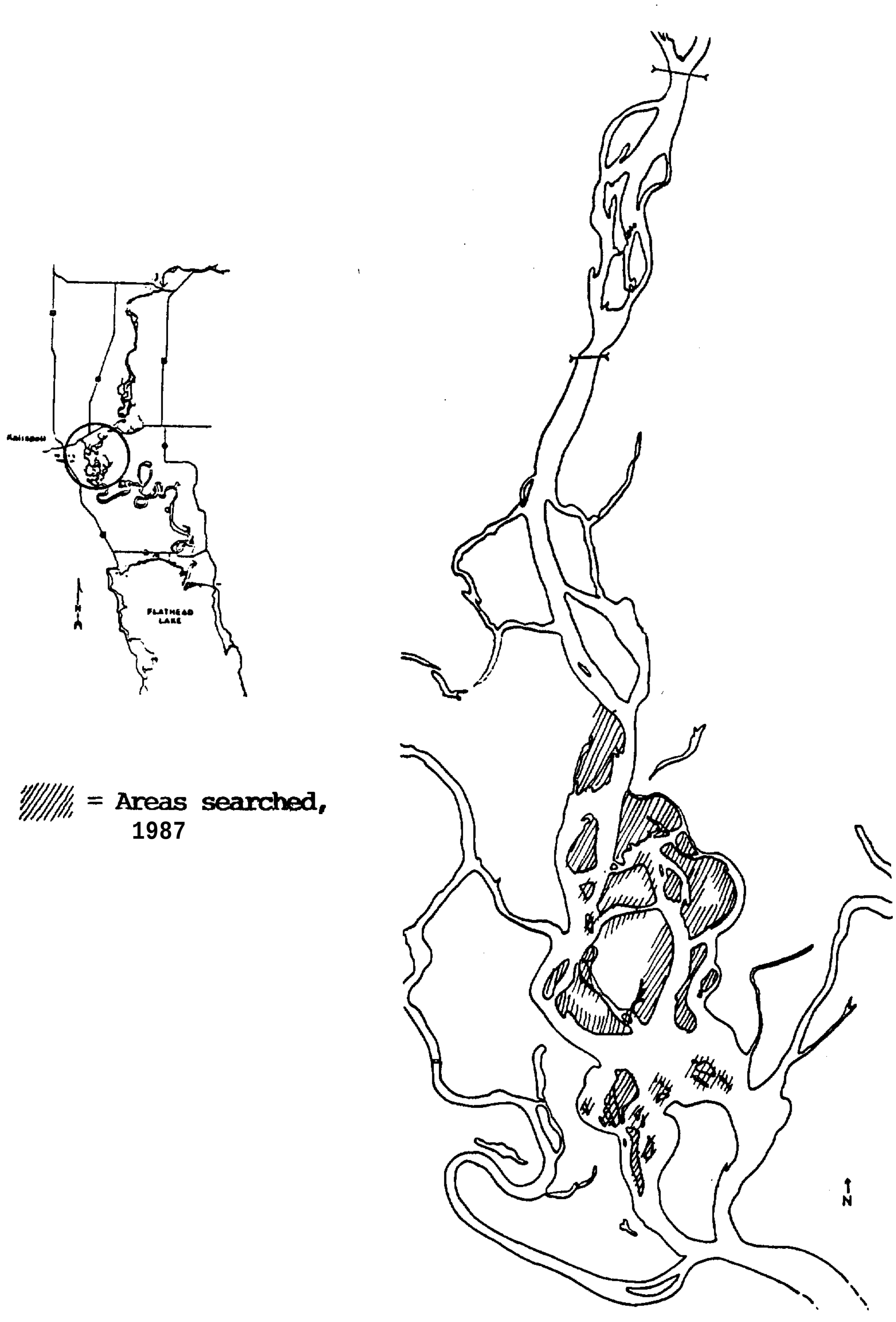
APPENDIX C

Areas searched for Canada goose groundnests, northern Flathead Valley, Montana, 1984-1987 (continued).



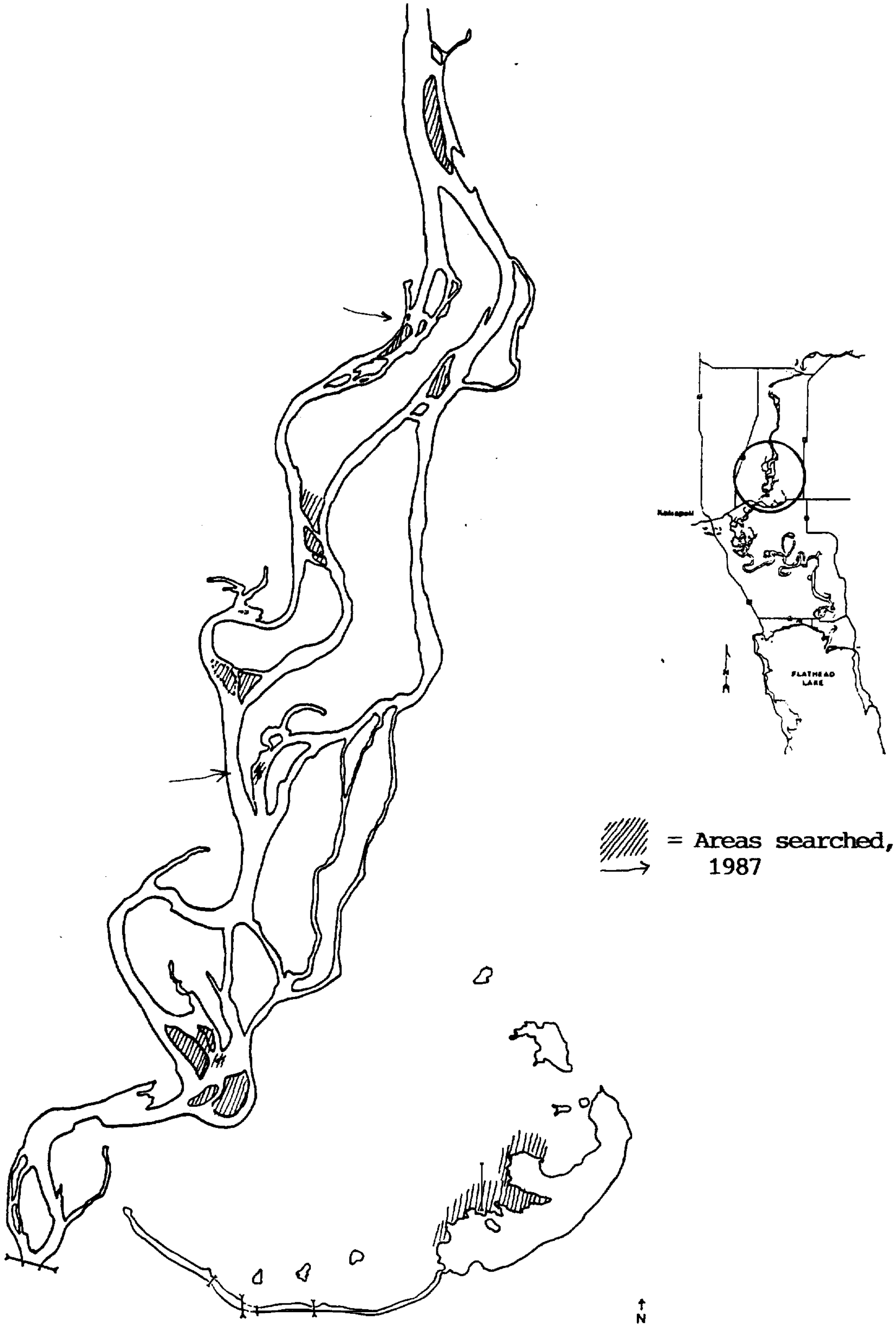
APPEUDIX C

Areas searched for Canada goose groundnests, northern Flathead Valley, Montana, 1984-1987 (continued).



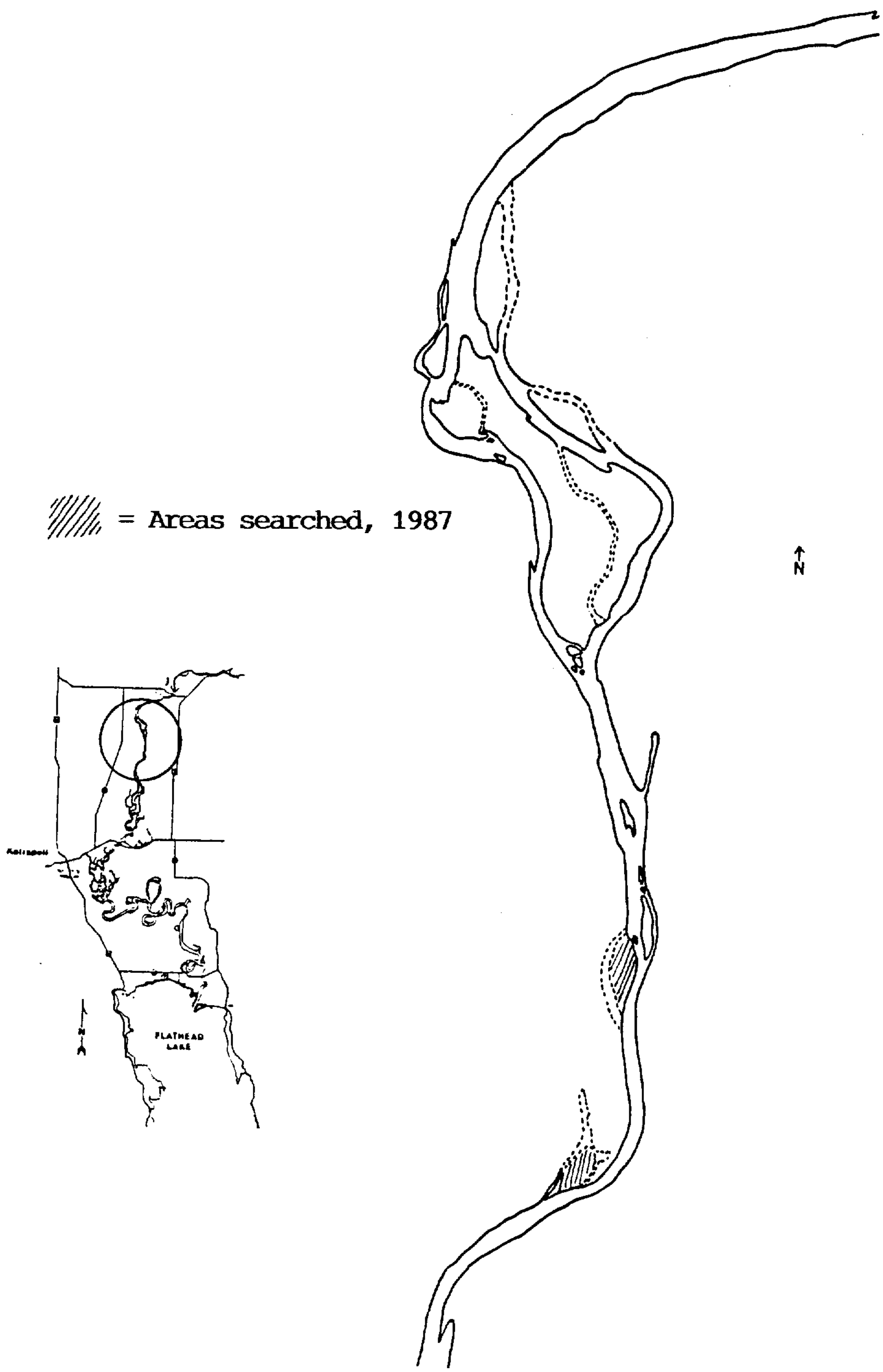
APPENDIX C

Areas searched for Canada goose groundnests, northern Flathead Valley, Montana, 1984-1987 (continued).



APPENDIX C

Areas searched for Canada goose groundnests, northern Flathead Valley, Montana, 1984-1987 (continued).



APPENDIX D

Field data form used for Canada goose brood activity budget surveys,1985-1986.

5195-1 **BROOD SURVEY - TIME BUDGET** MDFWP

Date | Loc. | Map | Obs. | Time (S) | Int. | Time (F) | Total in Area: Ad. Gos. | Compass | Temp. | Weather | lake elev. | Gauge ht.

Observer:
1 DC
2 MW
3 KD

	Gosling 2 Act.	CT	LF	size class	Adult 1 Act.	CT	LF	Gosling 3 Act.	CT	LF	size class	Adult 2 Act.	CT	LF	Total # Gos.	Ad.	group type	reason	comment	
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				
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28																				
29																				
30																				

ACTIVITY

10 FEEDING
- 11 grazing
- 12 hawking
- 13 tipping
- 14 gleaning
- 15 pecking

20 RESTING

30 LOCOMOTION
- 31 walking
- 32 swimming
- 33 flying

40 COMFORT MOVEMENTS

50 SOCIAL INTERACTIONS

60 [illegible]

70 ALERT

80 DISTURBED
- 81 by observers
- 82 by other people
- 83 by dogs
- 84 by wild mammals
- 85 by wild birds
- 86 other

90 OUT OF SIGHT

Cover Types

10 Forest
- 11 Coniferous forest
- 12 Deciduous forest
- 13 Combination

20 Shrub
- 21 Dense shrub
- 22 Sparse shrub

30 Grass/Forb
- 31 Tall herbaceous
- 32 Short herbaceous
- 33 Med Herbaceous

40 Cultivated land
- 41 Pasture
- 42 Grainfield
- 43 Alfalfa
- 44 Orchard/Tree farm
- 45 Lawn
- 46 Other
- 47 Homesite

50 Marsh

60 Aquatic

70 Unvegetated

Landforms

10 Water
- 11 River
- 12 Stream
- 13 Backwater
- 14 Lake
- 15 Reservoir
- 16 Pond
- 17 Marsh

20 Intertidal-Shoreline
- 21 Gravel bar
- 22 Rocky bank
- 21 Clay bank
- 24 Clay cliffs
- 25 Rock cliffs
- 26 Mud flat
- 27 Marsh
- 28 Developed dock area

30 Riparian
- 31 Bench/Flat area
- 32 Undulating
- 33 Slope-hillside
- 34 Cliff

40 Upland
- 41 Flat
- 42 Slope-hillside
- 43 Undulating
- 44 Cliff

Group Type

1=single
2=pair
3=single w/brood
4=pair w/brood
5=goslings
6=gang brood
7=flock
8=single brood w/in gang brood

Weather:

1 Clear
2 Partly cloudy
3 Overcast
4 Rain (light)
5 Rain (heavy)
6 Hail/Snow

Reasons for switching

1 Time period over
2 Brood mixing
3 Left area (known)
4 Recording interrupted

50 Deep Bay, Hughes Bay
51 Angel Point
52 Conrad Point, Peaceful Bay
53 Lakeside
54 Point Caroline
55 Somers Bay - Marina
56 Somers Islands
57 Kalispell Bay
58 Bigfork - Swan River mouth
59 East Shore - Woods Bay
60 Flathead River mouth (WPA)
61 Delta islands (WPA)
62 WPA East of river
63 WA West
64 WPA West (closed, hunting)
65
71 Tower 1, WPA
72 Tower 2, WPA
73 Tower 3, WPA
66
70 River (Rose Cr. to mouth)
71 River (Mill Cr. - Rose Cr.)
72 River (Church S.- Mill Cr.)
73 River (Half Moon S.-Church)
74 River (Salmon Hole-Half M.)
75 River (Hwy 2 - Salmon Hole)
76 River (Presentine - Hwy 2)
77 River (Hwy 40 -Presentine)
78 River (South Fork- Hwy 40)
79 Columbia Falls Slough
80 Fennon Slough
81 Rose Creek
82 Mill Creek
83 Church Slough
84 Egan Slough
85 Half Moon Slough
86 Brenneman Slough
87 Shaw's Slough
88 McWenneger Slough
89 Hodgeson Lake
90 Ponds n. of Fennon
91 Robocker's ponds
92 Weaver Slough
93 Swim Creek
94 Sliter's ponds
95 Fairview Marsh
96 Ponds n. of Foy's
97 Mourning Slough, etc.
98 Mud Lake / Johnson L.
99 Batavia/Smith L. WPA's

APPENDIX E

Cover types, based on existing plant species dominance, used to describe Canada goose nest and brood-rearing sites, northern Flathead Valley, Montana.

Code	Type
CF	Coniferous forest - All forest stands dominated by mature coniferous trees >4.8 m tall and >25% canopy cover. - Tree species include: Douglas-fir (*Pseudotsuga menziesii*), spruce (*Picea* spp.), larch (*Larix occidentalis*), and Ponderosa pine (*Pinus ponderosa*).
DF	Deciduous forest - Forest stands dominated by cottonwood tree with no differentiation based on age or height of trees. - Tree species include: black cottonwood (*Populus trichocarpa*), aspen (*Populus tremuloides*), birch (*Betula papyrifera*).
DFM	Mature deciduous forest - Includes forest stands dominated by older cottonwood trees with dense (>75%) canopy cover. - Contains less than 20% canopy cover of coniferous trees.
DFI	Immature deciduous forest - Includes forests dominated by younger aged cottonwood trees at least 4.8 m tall. - Generally individual trees would not support nests for osprey or Canada geese.
CD	Mixed forest - conifer/deciduous - Forest stands dominated by mature cottonwood and coniferous trees at least 4.8 m tall. - Must contain at least 20% canopy cover of either deciduous or coniferous trees to be mixed forest.
DS	Dense shrub - Areas dominated by unidentified shrubs with at least 20% cover.
DSM	Dense shrub - mixed - Areas dominated by very dense (generally greater than 50% cover) of mixed shrubs including red-osier dogwood (*Cornus stolonifera*), chokecherry (*Prunus virginiana*), Douglas hawthorn (*Crataegus douglasii*), and alder (*Alnus* sp.).

APPENDIX E

Cover types, based on existing plant species dominance, used to describe Canada goose nest and brood-rearing sites, northern Flathead Valley, Montana (continued).

Code	Type
DSCW	Dense shrub - cottonwood/willow - Includes areas of dense cottonwood willow regeneration on gravel bars and islands. - Cottonwoods and willows must be less than 4.8 m tall to be considered as shrubs.
SS	Sparse shrub - Includes areas of sparse shrub (between 10-20% cover). - Species composition is unknown.
SSCW	Sparse shrub - cottonwood/willow - Includes areas of sparse cottonwood/willow regeneration usually found on gravel bars. - Cottonwoods and willows must be less than 4.8 m tall to be considered as shrubs.
HERB	Herbaceous - Includes natural herbaceous areas dominated by forbs and grasses, generally associated with moist sites adjacent to the river or lake. - Forb species included: horsetails (Equisetum spp.), clovers (Trifolium spp.), plantain (Plantago major), and several others. - Grass species included: reed canary grass (Phalaris arundinaceae), spike-rush (Eleocharis spp.), sedges (Carex spp.), wheatgrass (Agropyron spp.), bluegrass (Poa spp.), and bentgrass (Agrostis spp.). - In some cases, this cover type was further described based on the height of the vegetation: tall herbaceous (>.5 m), medium herbaceous (.10 - .50 m), short herbaceous (<.1 m).
PAST	Pasture - Native and non-native grass pastures grazed by livestock.
CULT	Cultivated - Cultivated fields, usually wheat or barley crops.
DEV	Developed - Includes homesites, farms, buildings.

APPENDIXE

Cover types, based on existing plant species dominance, used to describe Canada goose nest and brood-rearing sites, northern Flathead Valley, Montana (continued).

Code	Type
MARS	Marsh - Includes sites with cattails (Typha spp.), flowering rush (Butomus umbellatus), and other emergent vegetation.
AQUA	Aquatic vegetation - Includes ponds or sloughs with submerged aquatic plants. - Species included: Elodea spp., Polygonum amphibium, Potamogeton spp., Ceratophyllum demersum, Lemna spp., and Myriophyllum spp.
UNVEG	Unvegetated - Includes unvegetated sites such as roads, gravel bars and open water areas.

APPENDIXF

Landforms used to describe Canada goose nest and brood-rearing sites in the northern Flathead Valley, Montana.

1.0	Island
1.1	River
1.2	Stream
1.3	Backwater/channel
1.4	Lake
1.6	Pond/slough
1.7	Marsh
2.0	Intertidal-shoreline
2.1	Gravel bar
2.6	Mudflat
3.1	Riparian bench/flat area
3.2	Riparian swale
3.3	Riparian slope
4.1	Upland flat
4.2	Upland slope
4.3	Upland swale

APPENDIX G

Status of radio-equipped Canada geese found in the northern Flathead Valley.

COLLAR NUMBER	AGE/SEX		TRAP DATE	TRAP LOCATION	NUMBER OF LOCATIONS	LOCATION/COMMENTS	STATUS
MY01	A	F	02-26-85	River	18	Egan Slough	No locations after 5-22-85
MY02	SA	M	02-27-85	River	7	Lower Valley, Rose Creek	No locations after 3-28-86
MY03	A	M	02-27-85	River	37	Braided area, McWenneger Slough	Shot 12-31-86 Lower Valley
MY04	A	F	02-28-85	River	12	South end, lake, paired with MY05	No locations after 10-26-86
MY05	A	M	02-28-85	River	25	South end, lake; paired with MY04	No locations after 10-26-86
MY07	SA	M	02-28-85	River	7	Lower river and valley; frequency overlap with CSKT collar	Shot 12-11-85 Idaho
MY09	A	M	02-28-85	River	2	Delta island; possible frequency overlap with CSKT collar	Shot 12-7-85 Idaho
MY10	A	M	02-28-85	River	4	WPA to Polson return WPA	No locations after 3-27-85
MY11	A	M	02-28-85	River	4	Lower river to Polson, north shore	No locations after 3-4-86
MY12	A	F	02-28-85	River	4	Lower river and valley	Shot 12-7-85 Idaho
MY13	A	M	03-05-85	River	29	Egan Slough; raised brood	No locations after 3-4-86
MY14	A	M	03-05-85	River	35	No locations after 10-26-86	No locations after 10-26-86
Mn5	A	F	03-12-85	River	64	Foy's Bend, Half Moon and Weaver Slough; paired with MY17; raised brood	Present as of 5-14-87
MY16	SA	M	03-12-85	River	2	Lower river and WPA	Weak signal 2-19-86
MY17	A	M	03-12-85	River	83	Foy's Bend, Half Moon & Weaver Slough, paired with MY15; raised brood	Present as of 5-14-87
MY18	A	M	06-27-85	WPA	14	WPA and Lower Valley; Johnson Lake	No location after 10-10-85
MY19	A	F	06-U-85	WPA	8	WPA and Lower Valley	Shot 9-28-85 Lower Valley
MY52	A	M	06-27-85	WPA	13	WPA, Columbia Falls, Pablo Reservoir, Johnson Lake	Shot 11-24-85 above Highway 2
MY53	A	M	06-27-85	WPA	15	WPA, Lower Valley, Pablo Reservoir, Mud Lake	Dead Z-20-86 below Kerr Dam
MY54	A	M	06-27-85	WPA	11	WPA, Lower Valley	Shot 12-3-86 Idaho
MY55	A	M	06-27-85	WPA	36	WPA, Lower Valley Pablo Reservoir	Present as of 5-6-87
MY56	A	M	06-27-85	WPA	10	WPA, Lower Valley Pablo Reservoir	No locations after 10-3-85
MH89	A	F	06-27-84	WPA	8	No recent locations	No locations after 10-18-84
MH12	A	F	01-25-84	Elmo Bay	22	Braided area, WPA; raised brood	No locations after 4-1-86
MH84	A	F	02-22-85	River below Kerr Dam	37	Cedar Island (south Flathead Lake), WPA; raised brood	Present as of 5-6-87
MY70	A	F	03-20-86	River	11	Egan Slough	Present as of 4-17-87
MY76	A	M	03-24-86	River	12	Egan Slough	No locations after 5-8-86
MY77	A	F	04-01-86	River	30	Lower river; raised brood	Shot 12-3-86 Lower river

APPENDIX H

Results of aerial surveys of Canada geese, northern Flathead Valley, April 1984 - May 1987.

Mo. Day Yr	Flathead WPA and North Shore	Lower River (below Kalispell)	Upper River (above Kalispell)	McWenn. Slough	Fairview Marsh	Lower Valley	Mud and Johnson Lakes	Lower Swan River	Study Area Total
Apr 21 84	80	102	8	-	-	-	-	-	190
Apr 25 84	75	107	2	20	-	-	-	-	204
May 02 84	75	77	8	4	-	1	-	-	165
May 21 84	139	87	-	-	-	-	-	-	226
May 30 84	127	35	12	3	-	-	-	-	177
Jun 05 84	138	12	0	4	-	-	-	-	154
Jun 13 84	42	4	4	0	-	-	-	-	50
Jun 29 84	171	13	0	0	-	-	-	-	184
Jul 06 84	117	125	0	16	0	-	-	-	258
Jul 13 84	70	107	0	-	-	-	-	-	177
Jul 22 84	39	76	0	18	-	13	-	-	146
Jul 28 84	12	169	-	-	-	21	-	-	202
Aug 02 84	100	253	32	0	0	-	-	-	385
Aug 10 84	224	215	0	0	-	28	-	-	467
Aug 18 84	4	240	-	0	0	-	-	-	244
Aug 24 84	0	242	0	7	-	-	-	-	249
Sep 05 84	336	192	65	0	0	65	-	-	658
Sep 25 84	922	23	-	180	0	-	115	47	1240
Sep 27 84	514	151	0	0	0	-	-	-	672
Oct 10 84	94	26	0	0	2	175	85	-	382
Oct 18 84	43	229	-	0	0	30	-	-	302
Nov 05 84	562	143	0	0	5	-	180	360	890
Nov 15 84	259	151	0	0	124	1	233	-	768
Dec 04 84	253	121	59	0	0	-	0	-	433
Dec 14 84	40	63	-	0	0	-	0	180	103
Jan 11 85	36	455	62	-	-	-	-	-	553
Jan 31 85	0	434	49	-	-	-	-	-	483
Feb 14 85	0	640	0	-	-	-	-	-	640
Mar 07 85	157	797	8	0	-	-	-	-	962
Mar 15 85	821	366	29	0	0	-	-	-	1216
Mar 20 85	318	177	17	0	-	1465	-	-	1977
Mar 28 85	387	382	93	7	-	542	-	-	1411
Apr 02 85	79	156	13	22	-	25	-	-	295
Apr 09 85	116	148	25	32	-	10	-	-	331
Apr 16 85	76	137	19	23	10	17	-	-	282
Apr 24 85	87	170	9	17	-	6	-	-	289
Apr 30 85	62	183	19	19	-	17	-	-	300
May 07 85	122	123	8	13	-	8	-	-	274
May 14 85	148	160	12	10	-	14	-	-	344
May 22 85	294	235	4	34	-	55	-	-	616
May 29 85	281	126	87	2	-	25	-	-	521

APPENDIX H

Results of aerial surveys of Canada geese, northern Flathead Valley, April 1984 - May 1987 (continued).

Mo. Day Yr	Flathead WPA and North Shore	Lower River (below Kalispell)	Upper River (above Kalispell)	McWenn. Slough	Fairview Marsh	Lower Valley	Mud and Johnson Lakes	Lower Swan River	Study Area Total
Jun 06 85	99	-	-	10	-	16	-	-	124
Jun 18 85	48	20	0	6	-	10	8	-	92
Jul 03 85	95	64	0	26	-	40	23	-	248
Jul 24 85	99	71	-	80	-	202	0	-	452
Aug 01 85	217	52	-	43	0	196	-	-	508
Aug 13 85	449	95	118	22	-	49	35	-	768
Aug 29 85	1	84	128	0	8	319	-	-	540
Sep 13 85	9	128	106	25	39	326	-	-	633
Sep 27 85	5	227	0	0	0	450	17	-	699
Oct 10 85	0	62	0	0	0	2	461	-	522
Oct 24 85	4	87	14	0	0	0	234	-	339
Nov 06 85	84	424	93	0	0	2	283	-	886
Nov 22 85	281	23	74	0	-	143	54	-	575
Dec 04 85	0	16	0	-	-	35	0	-	51
Dec 16 85	13	17	65	0	0	-	0	-	95
Jan 03 86	0	301	61	0	0	0	0	11	362
Jan 10 86	5	339	7	0	0	0	-	-	351
Jan 24 86	0	559	7	0	0	0	0	18	566
Feb 05 86	102	516	0	0	0	0	22	9	640
Mar 04 86	1814	300	13	8	-	0	7	27	2142
Mar 11 86	821	508	26	6	-	350	2	39	1713
Mar 20 86	210	216	3	23	0	114	-	-	566
Mar 26 86	124	122	4	23	-	28	-	-	301
Apr 02 86	118	163	2	38	-	14	-	-	335
Apr 10 86	90	110	8	26	-	16	-	-	250
Apr 15 86	80	90	14	30	-	16	-	-	230
Apr 23 86	33	130	-	-	-	-	-	-	163
May 08 86	76	126	10	26	-	34	-	-	272
May 16 86	180	122	35	57	-	12	-	-	406
May 23 86	161	132	11	49	-	39	-	-	392
May 29 86	301	97	2	17	-	38	5	-	460
Jun 06 86	141	114	5	14	-	51	-	-	325
Jun 11 86	72	40	0	14	-	22	-	-	150
Jun 18 86	56	47	8	17	-	42	-	-	170
Jun 23 86	54	93	4	16	-	19	-	-	186
Jul 02 86	67	115	19	20	-	32	-	-	253
Jul 16 86	67	105	0	13	29	77	42	25	333
Jul 30 86	360	269	0	0	-	289	44	0	962
Aug 14 86	125	89	0	-	-	277	100	0	591
Aug 27 86	211	82	0	0	1	227	-	-	521
Sep 10 86	31	272	24	0	0	312	0	0	639
Sep 26 86	96	42	0	0	125	505	55	0	859

Results of aerial surveys of Canada geese, northern Flathead Valley, April 1984 - May 1987 (continued).

Mo. Day Yr	Flathead WPA and North Shore	Lower River (below Kalispell)	Upper River (above Kalispell)	McWenn. Slough	Fairview Marsh	Lower Valley	Mud and Johnson Lakes	Lower Swan River	Study Area Total
Oct 08 86	11	1	93	0	0	37	476	0	622
Oct 29 86	4	62	109	0	48	201	4	0	428
Nov 12 86	141	579	54	0	0	0	29	119	803
Nov 25 86	556	491	0	0	0	28	0	117	1075
Dec 10 86	393	588	19	0	0	0	0	136	1000
Dec 24 86	472	515	0	0	0	0	0	147	987
Jan 07 87	682	186	0	0	0	0	0	0	868
Jan 22 87	74	1316	0	0	0	0	0	0	1390
Feb 04 87	171	1188	0	0	0	0	0	0	1359
Feb 20 87	240	932	14	2	-	16	0	20	1204
Mar 12 87	741	650	0	23	-	137	-	-	1551
Mar 27 87	217	381	99	25	-	81	-	-	803
Apr 10 87	136	164	18	29	-	14	-	-	361
Apr 17 87	115	53	-	-	-	8	-	-	176
Apr 30 87	187	130	18	22	-	20	-	-	377
May 07 87	184	177	19	19	-	19	-	-	418
May 14 87	238	160	3	40	-	58	-	-	499

APPENDIX1

Canada goose nests, type location and fate, northern Flathead Valley, 1986.

Nest Code	Nest Type	Location	Clutch Size	Fate
A01	Structure	Somers	u	Hatched
A02	structure	Somers	u	Hatched
A04	structure (osprey)	Somers	U	Unknown
B03	Tree (osprey)	WPA(River Mouth)	u	Hatched
B04	Tree (osprey)	WPA(RiverMouth)	U	Unknown
B06	Stump (osprey)	WPA (RiverDelta)	U	Hatched
B20	stuup	WPA (RiverDelta)	U	Hatched
B22	stw	WPA (River Delta)	6	Hatched
B25	Stump	WPA(RiverDelta)	6	Hatched
B26	Stump	WPA (RiverDelta)	U	Hatched
B26	Stump	WPA (RiverDelta)	5	Abandoned
B30	Stump	WPA (RiverDelta)	5	Unknown
B32	Stump	WPA (River Delta)	4	Hatched
B38	Tree (osprey)	WPA (River Mcuth)	U	Hatched
B40	Structure	WPA (West Ponds)	U	Prediation
B41	Stump	WPA (River Delta)	5	Unknown
B42	Stump	WPA (River Delta)	5	unknown
B43	Stump	WPA (River Delta)	U	Hatched
B43	Stump	WPA (River Delta)	5	Flooded
B44	Stump	WPA (River Delta)	6	Hatched
B45	Stump	WPA (River Delta)	6	Hatched
B46	Stump	WPA (River Delta)	4	Unknown
B47	Stump	WPA (River Delta)	5	Hatched
B55	Stump	WPA (River Delta)	5	Hatched
co2	Tree (osprey)	Lower River	U	Hatched
co5	Structure (osprey)	Lower River	U	Hatched
co9	Tree (osprey)	Lower River	4	Destroyed (wind)
Cll	Tree (bald eagle)	LcwerRiver(Fennon Slough)	U	Unknown
Cl5	Tree (osprey)	Lower River	3	Hatched
C32	Tree (osprey)	Lower River	6	Hatched
c35	Tree (osprey)	Lower River (Church Slough)	U	Destroyed (Wind)
c37	Tree (osprey)	Lower River	5	Hatched
C40	Tree (osprey)	Lower River	6	Hatched
c41	Structure (osprey)	Lower River	U	Unknown
c43	Tree (red-tailed hawk)	Lower River	5	Hatched
c49	Tree (osprey)	LmerRiver	6	Unknown
C50	Tree (osprey)	Lower River	U	Unknown
C52	Tree (osprey)	Lower River	7	Hatched
c54	snag	Lower River	4	Hatched
C65	snag	Lower River	3	Unknown
C72	snag	Lower River	2	Hatched
C76	snag	Lower River	5	Hatched
c77	snag	Lower River (Fennon Slought)	7	Hatched
C78	snag	Lower River	5	Hatched
c79	snag	Lower River	U	Hatched
C80	snag	Lower River	U	Unknown
C85	snag	Lower River	U	Predation
C86	snag	Lower River	4	Unknown
C87	snag	Lower River	U	Unknown

AFPENDIXI

Canada goose nests, type location and fate, northern Flathead Valley, 1986 (continued).

Nest Code	Nest Type	Location	Clutch Size	Fate
C88	Tree (great blue heron)	Lower River	2	Hatched
C102	Tree (osprey)	Lower River (Fennon Slough)	U	Unknown
Cl05	Tree (osprey)	Lower River	5	Unknown
Cl08	Tree (osprey)	Lower River (Fennon Slough)	5	Hatched
C112	Stump	Lower River	5	Hatched
Cll3	Snag	Lower River	U	Predation
Cll5	Snag	Weaver Slough (Ashley Creek)	6	Hatched
Cll8	Snag	Lower River	6	Hatched
cll9	Snag	Weaver Slough (Ashley Creek)	U	Unknown
Cl2l	snag	Lower River	6	Hatched
Cl22	snag	Lower River	5	Unknown
Cl23	Snag	Lower River	5	Hatched
cl24	Snag	Lower River	7	Hatched
Cl25	Snag	Lower River	5	Unknown
Cl26	Snag	Lower River	6	Hatched
cl27	Snag	Lower River	4	Hatched
Cl28	Snag	Lower River	U	Hatched
cl29	Snag	Lower River	3	Hatched
cl30	Snag	Lower River	U	Unknown
Cl.31	Snag	Lower River	U	Unknown
cl32	Snag	Lower River	U	Hatched
DlO	Structure	Upper River	U	Hatched
Dll.	Structure	Upper River	U	Hatched
Dl2	Sructure	Upper River	U	Hatched
D03	Tree (golden eagle)	Upper River	6	Hatched
EOl	Structure	Weaver Slcugh (Ashley Creek)	U	Unknown
E08	Structure	Weaver Slough (Ashley Creek)	5	Hatched
HO1	Island ground	Upper River	5	Hatched
HO2	Marsh (grcxmd)	Lower River (Egan Slough)	6	Unknown
HO3	Islandgrolmd	Upper River	7	Predation
HO4	Island ground	Lower River	7	Hatched
HO5	Mainland ground	Lower River	5	Hatched
HO6	Marsh (ground)	Lower River (Egan Slough)	5	Hatched
HO7	Island ground	Upper River	U	Unknown
HO8	Island ground	Lower River(Fennon Sloug)	7	Predation (Bird)
HO9	Island ground	Lower River (Fennon Slough)	3	Predation (Bird)
H10	Island ground	Lower River (Fennon Slough)	6	Hatched
H11	Island ground	WPA (River Delta)	6	Flooded
Hl2	Island ground	WPA (River Delta)	5	Flooded
H13	Island ground	WPA (River Delta)	4	Unknown
Hl4	Island ground	WPA (River Delta)	7	Batched
Hl5	Island ground	WPA (River Delta)	5	Unknown
HI6	Islandgrolmd	WPA (River Delta)	7	Unknown
HI7	Island ground	WPA (River Delta)	5	Hatched
Hl8	Island ground	WPA (River Delta)	5	Hatched
H19	Island ground	Lower River	6	Hatched
H20	Island ground	Lower River	6	Hatched
H21	Island ground	Lower River	6	Hatched
H22	Island ground	Lower River	8	Hatched
H23	Island ground	Lower River	6	Predation(Mammal)

APPmDIxI

Canada goose nests, type location and fate, northern Flathead Valley, 1986 (continued).

Nest Code	Nest Type	Location	Clutch Size	Fate
H24	Island ground	Lower River	U	Abandoned
H25	Island ground	Lower River	U	Predatim
H26	Island ground	Lower River	5	Hatched
H27	Island ground	Lower River	6	Hatched
H28	Marsh (ground)	Lower River (Brosten's Pond)	5	Unknown
H29	Marsh (ground)	Lower River (Brosten's Pond)	5	Hatched
H30	Marsh (ground)	Lower River (Brosten's Pond)	U	Hatched
H31	Marsh (ground)	McWenneger Slough	4	Hatched
H32	Marsh (ground)	McWenneger Slough	U	Predation
H33	Marsh (ground)	McWenneger Slough	4	Unknown
H34	Marsh (grcmd)	McWenneger Slough	4	Abandoned
H35	Marsh (ground)	McWenneger Slough	5	Hatched
H36	Island ground	Upper River	7	Hatched
H37	Marsh (ground)	Lower River (Egan Slough)	6	Unknown
H38	Marsh (ground)	Lower River (Brosten's Pond)	U	Hatched
H39	Island ground	Somers	U	Hatched
H40	Islandgrolmd	Somers	5	Hatched
H41	Marsh (grcund)	Lower River (Brosten's Pond)	U	Hatched
H42	Marsh (ground)	Lower River (Brosten's Pond)	U	Abandoned
H43	Marsh (ground)	Lower River (Brosten's Pond)	U	Abandoned
H44	Island (ground)	Saners	5	Hatched
H45	Marsh (ground)	WPA (East Ponds)	4	Hatched
H46	Marsh (ground)	WPA (Fast Ponds)	9	Unknown
H47	Marsh (ground)	WPA (East Ponds)	1	Abandoned
H48	Marsh (ground)	WPA (West Ponds)	U	Predation
H49	Marsh (ground)	WPA (East Ponds)	1	Abandoned
H50	Marsh (ground)	WPA (West Ponds)	U	Predation
H51	Marsh (grcmd)	WPA (East Ponds)	3	Hatched
H52	Marsh (ground)	WPA (West Ponds)	U	Predaticm
H53	Marsh (grcund)	WPA (East Ponds)	5	Hatched
H54	Marsh (ground)	WPA (West Ponds)	U	Predatim
H55	Marsh (ground)	WPA (West Ponds)	U	Predation (Mammal)
H56	Marsh (ground)	WPA (West Ponds)	U	Predation
H57	Marsh (ground)	WPA (West Ponds)	U	Predatim
H58	Marsh (ground)	Lower River (Egan Slough)	U	Unknown
Ii59	Marsh (grcmd)	Montford Slough	U	Unknown
H60	Marsh (ground)	Shaw's Slough	U	Unknown

APPENDIX J

Canada goose nests, type, location and fate, northern Flathead Valley, 1987.

Nest Code	Nest Type	Location	Fate
A01	Structure	Somers	Hatched
A02	Structure	Somers	Hatched
Bo3	Tree (osprey)	WPA (River Mouth)	Unknown
B04	Tree (osprey)	WPA (River Mouth)	Unknown
B06	Stump (osprey)	WPA (River Delta)	Abandoned
B09	Sructure	WPA (River Mouth)	Unknown
B25	Stump	WPA (River Delta)	Predatim
B32	Stump	WPA (River Delta)	Predation (mammal)
B38	Tree (osprey)	WPA (River Mouth)	Hatched
B44	Stump	WPA (River Delta)	Hatched
B45	Stump	WPA (River Delta)	Predation
B59	Structure	WPA (West Boundary)	Unknown
B66	Stump	WPA (River Delta)	Predation
B67	Stump	WPA (River Delta)	Predation
B67	Stump	WPA (River Delta)	Flooded
B68	Stump	WPA (River Delta)	Predation
B69	Stump	WPA (River Delta)	Unknown
B70	Stump	WPA (River Delta)	Hatched
B71.	Stump	WPA (River Delta)	Predation
B72	Stump	WPA (River Delta)	Predation
B73	Stump	WPA (River Delta)	Unknown
B74	Stump	WPA (River Delta)	Flooded
B74	Stump	WPA (River Delta)	Predation
B75	Stump	WPA (River Delta)	Predatim
co1	Tree (osprey)	Lower River	Unknown
Co3	Structure (osprey)	Lower River	Abandoned
co5	Structure (osprey)	Lower River	Unknown
C06	Structure (osprey)	Lower River	Unknown
Cll	Tree (bald eagle)	Lower River (Fennon Skough)	Unknown
Cl3	Tree (osprey)	Lower River	Unknown
Cl7	Tree (osprey)	Lower River	Hatched
C20	Tree (bald eagle)	Lower River	Unknown
c22	Tree (osprey)	Lower River	Unknown
c23	Tree (osprey)	Lower River	Unknown
C32	Tree (osprey)	Lower River	Unknown
c37	Tree (osprey)	Lower River	Predation
c40	Tree (osprey)	Lower River	Unknown
c49	Tree (osprey)	Lower River	Unknown
C54	Snag	Lower Rvier	Unknown
C62	Tree (osprey)	Lower River	Unknown
C65	Snag	Lower River	Unknown
C72	Snag	Lower River	Unknown
C80	Snag	Lower River	Unknown
C83	Tree (osprey)	Lower River	Unknown
C84	Snag	Lower River	Unknown
C87	Snag	Lower River	Unknown
c95	Tree (osprey)	Lower River	Unknown
c97	Tree (osprey)	Lower River	Unknown
Clll	Tree (red-tailed hawk)	Lower River	Unknown

APPENDIX J

Canada goose nests, type, location and fate. northern Flathead Valley, 1987 (continued).

Nest Code	Nest Type	Location	Fate
C115	Snag	Lower River	Unknown
cl24	Snag	Lower River	Hatched
Cl25	Snag	Lower River	Unknown
cl27	Snag	Lower River	Unknown
Cl28	Snag	Lower River	Unknown
cl29	Snag	Lower River	Hatched
cl32	Snag	Lower River	Unknown
cl35	Tree (osprey)	Lower River	Unknown
C140	Stump	Lower River (Fennon Slough)	Predation
Cl42	Snag	Lower River (Fennon Slough)	Unknown
C143	Snag	Lower River (Fennon Slough)	Predaticm
C144	Snag	Lower River	Unknown
C145	Snag	Lower River	Unknown
Cl46	Snag	Lower River	Unknown
C147	Snag	Lower River	Unknown
Cl48	Snag	Lower River	Unknown
C149	Snag	Lower River	Unknown
cl50	Snag	Lower River	Unknown
Cl51	Snag	Lower *River*	Unknown
D06	Structure (osprey)	Upper River	Unknown
D11	Structure	Upper River	Unknown
D15	Structure	Upper River	Unknown
E02	Structure	Weaver Slough (Ashley Creek)	Unknown
E08	Structure	Weaver Slough (Ashley Creek)	unknown
El3	structure	Upper Spring Creek	Unknown
101	Islandground	Upper River	Predation
102	Island ground	Upper River	Hatched
103	Island ground	Upper River	Flooded
104	Island gramd	Upper River	Flooded
105	Islandground	LowerRiver	Batched
106	Island ground	Lower River	Hatched
107	Island ground	Lower River	Hatched
108	Island ground	Lower River	Predation
109	Island ground	Lower River	Hatched
I10	Islandground	Lower River	Hatched
Ill	Island ground	Lower River	Unknown
I12	Island ground	Lower River	Hatched
I13	Island ground	Lower River	Hatched
I14	Island ground	Lower River	Hatched
I15	Islandground	Lower River	Hatched
I16	Islandground	Lower River	Hatched
I17	Islandgrcnmd	Lower River	Hatched
I18	Island ground	Lower River	Hatched
I19	Island ground	Lower River	Hatched
I20	Island ground	Somers	Unknown
I21	Islandground	Somers	Abandoned
I22	Island ground	Somers	Abandoned
I23	Islandgrolmd	Somers	Unknown
I24	Islandgrcmd	Somers	Unknown
I25	Island ground	Somers	Unknown

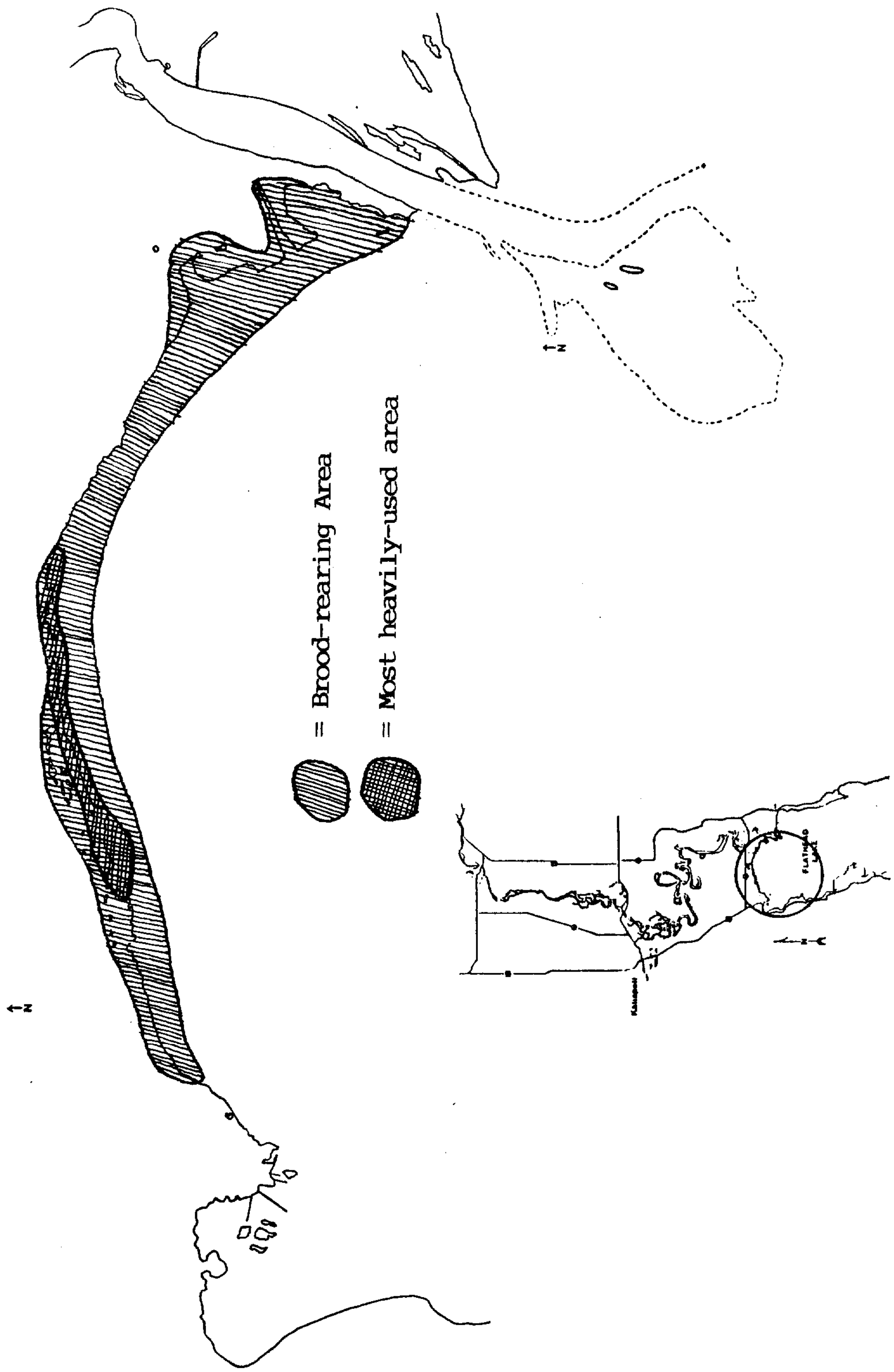
APPENDIX J

Canada goose nests, type, location and fate, northern Flathead Valley, 1987 (continued).

Nest Code	Nest Type	Location	Fate
I26	Marsh (ground)	WPA (East Ponds)	Hatched
I27	Island ground	WPA (River Delta)	Unknown
I28	Island ground	WPA (River Delta)	Unknown
I29	Marsh (ground)	WPA (West Ponds)	Predaticm
I30	Marsh (ground)	WPA (West Ponds)	Predatim
I31	Marsh (ground)	WPA (West Ponds)	Predaticm
I32	Marsh (ground)	WPA (West Ponds)	Predaticm
I33	Marsh (ground)	WPA (West Ponds)	Predaticm
I34	Marsh (ground)	WPA (West Ponds)	Predatim
I35	Marsh (ground)	WPA (West Ponds)	Predatim
I36	Marsh (ground)	WPA (West Ponds)	Predatim
I37	Marsh (ground)	WPA (West Ponds)	Predation
I38	Marsh (ground)	WPA (East Ponds)	Hatched
I39	Marsh (ground)	WPA (East Ponds)	Unknown
140	Marsh (ground)	WPA (East Ponds)	Hatched
141	Marsh (ground)	WPA (East Ponds)	Hatched
142	Marsh (ground)	WPA (East Ponds)	Hatched
143	Marsh (ground)	WPA (East Ponds)	Unknowned
144	Marsh (ground)	WPA (East Ponds)	Predaticm
145	Marsh (ground)	Lower River (Brosten's Pond)	Predatim
146	Marsh (ground)	Lower River (Brosten's Pond)	Abandoned
147	Marsh (ground)	Lower River (Brosten's Pond)	Predaticm
148	Marsh (ground)	McWenneger Slough	Abandoned
149	Marsh (ground)	McWenneger Slough	Predatim (mammal)
I50	Marsh (ground)	McWenneger Slough	Abandoned
151	Marsh (ground)	McWenneger Slough	Unknown
I52	Marsh (ground)	Lower River (Egan Slough)	Unknown
I53	Marsh (ground)	Lower River (Egan Slough)	Unknown
I54	Marsh (ground)	Lower River (Egan Slough)	Unknownon
I55	Island ground	Lower River (Fennon Slough)	Predation
I56	Island ground	Lower River (Fennon Slough)	Unknown
157	Island ground	Lower River (Fennon Slough)	Hatched
I58	Island ground	Lower River (Fennon Slough)	Predatim
159	Marsh (ground)	Lower River (Brosten's Pond)	Unknown
160	Marsh (ground)	Lower River (Brosten's Pond)	Unknown

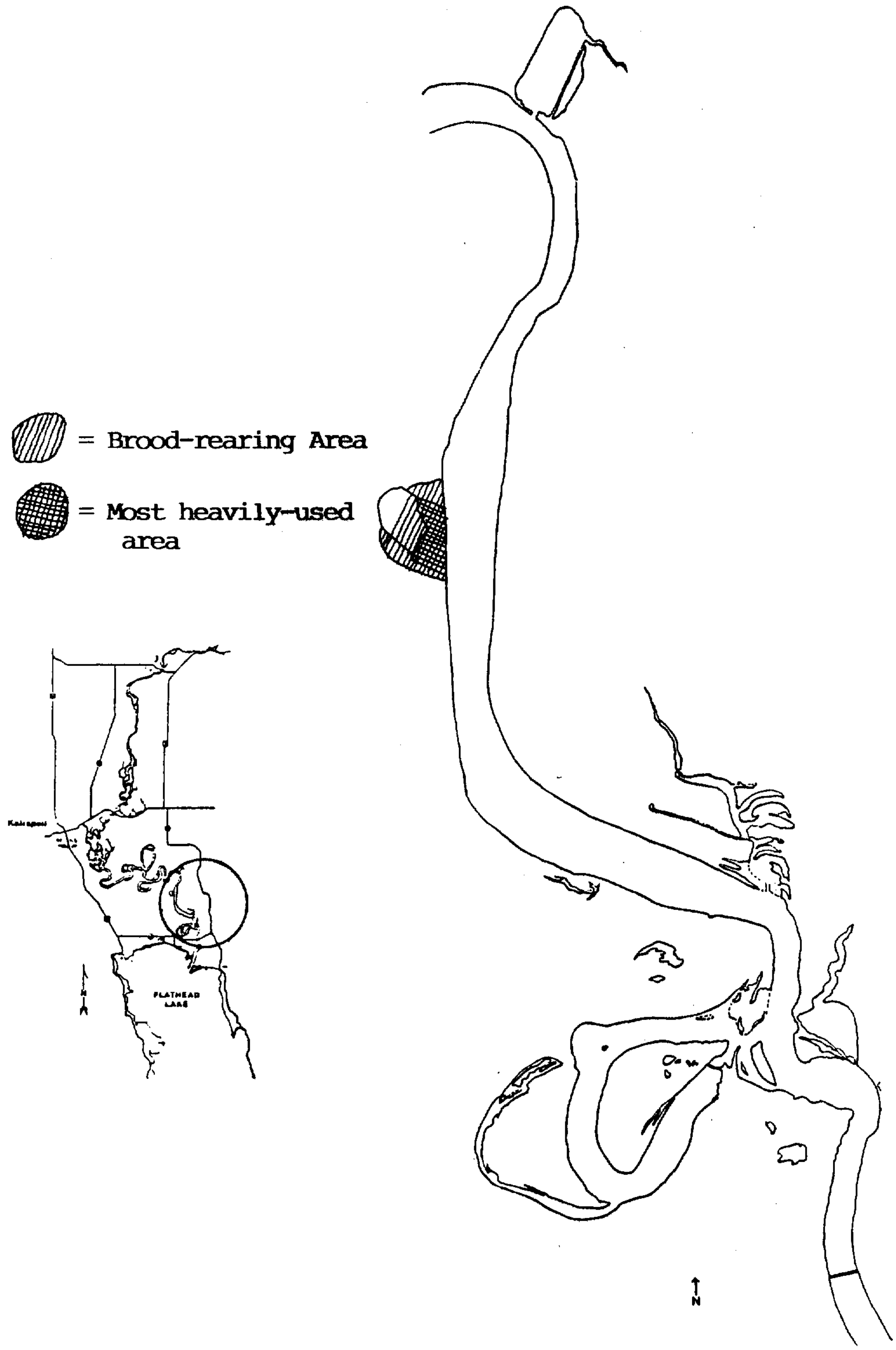
APPENDIX K

Known Canadagoose brood-rearing areas, northern Flathead Valley, Montana, 1984-1987.



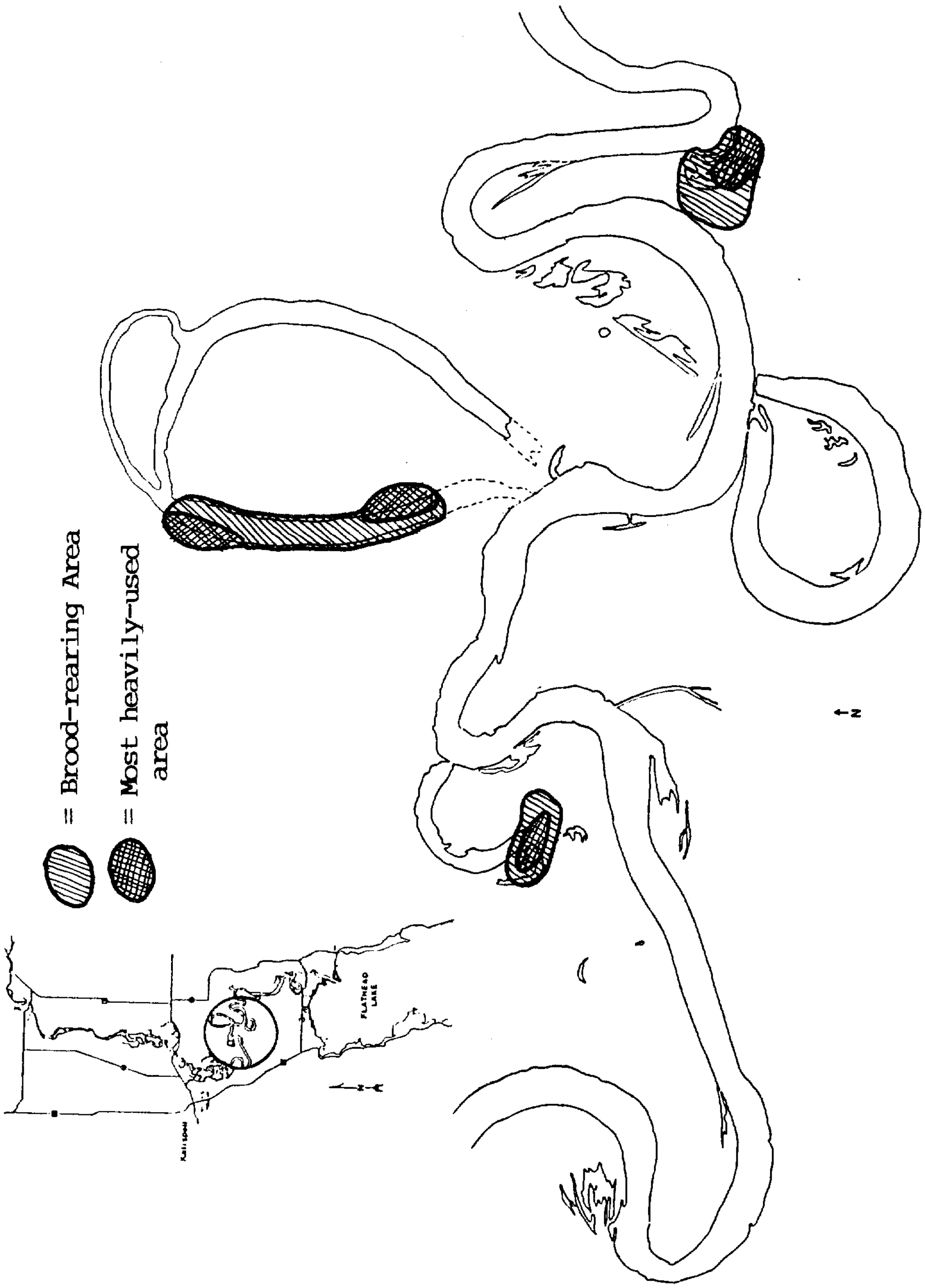
APPENDIX K

Known Canada goose brood-rearing areas, northern **Flathead** Valley, Montana, 1984-1987 (continued).



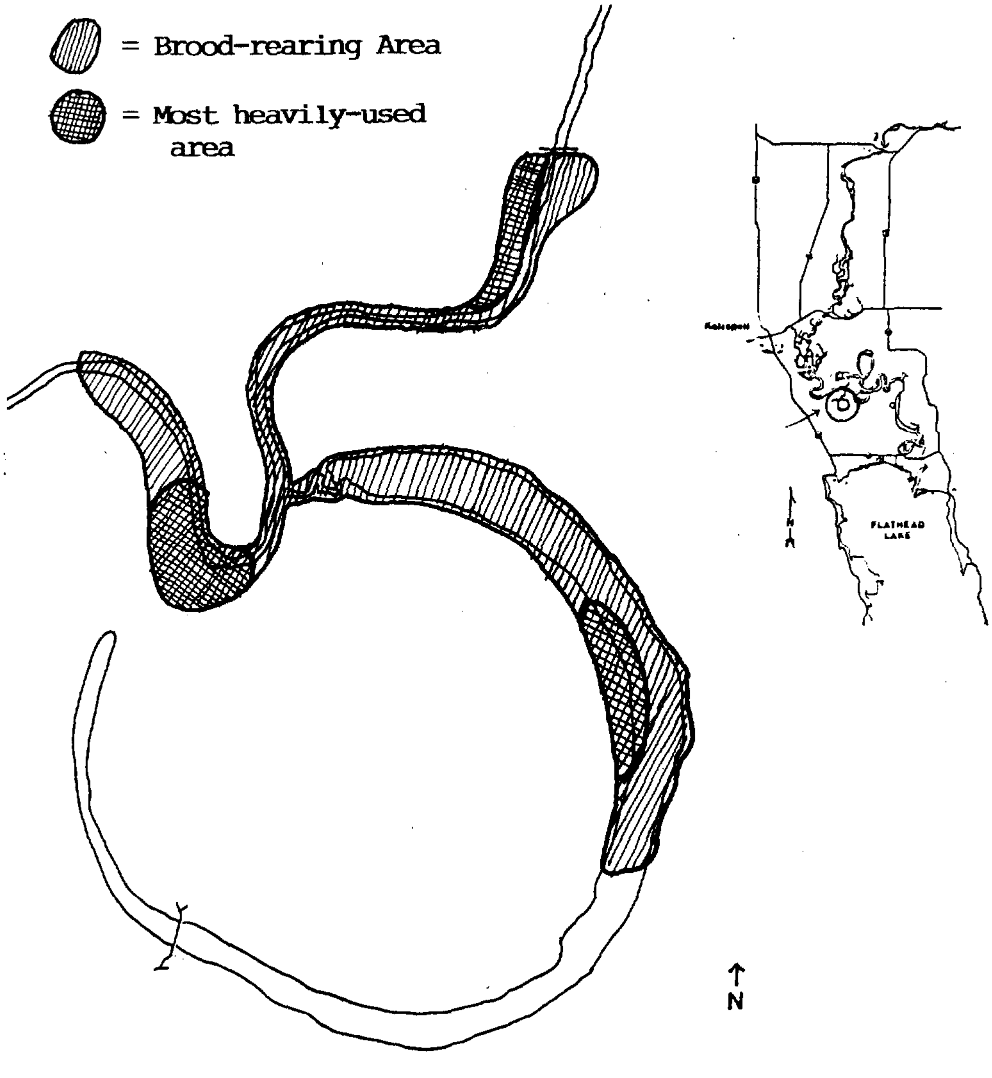
APPENDIX K

Known Canada goose brood-rearing areas, northern Flathead Valley, Montana, 1984-1987 (continued).



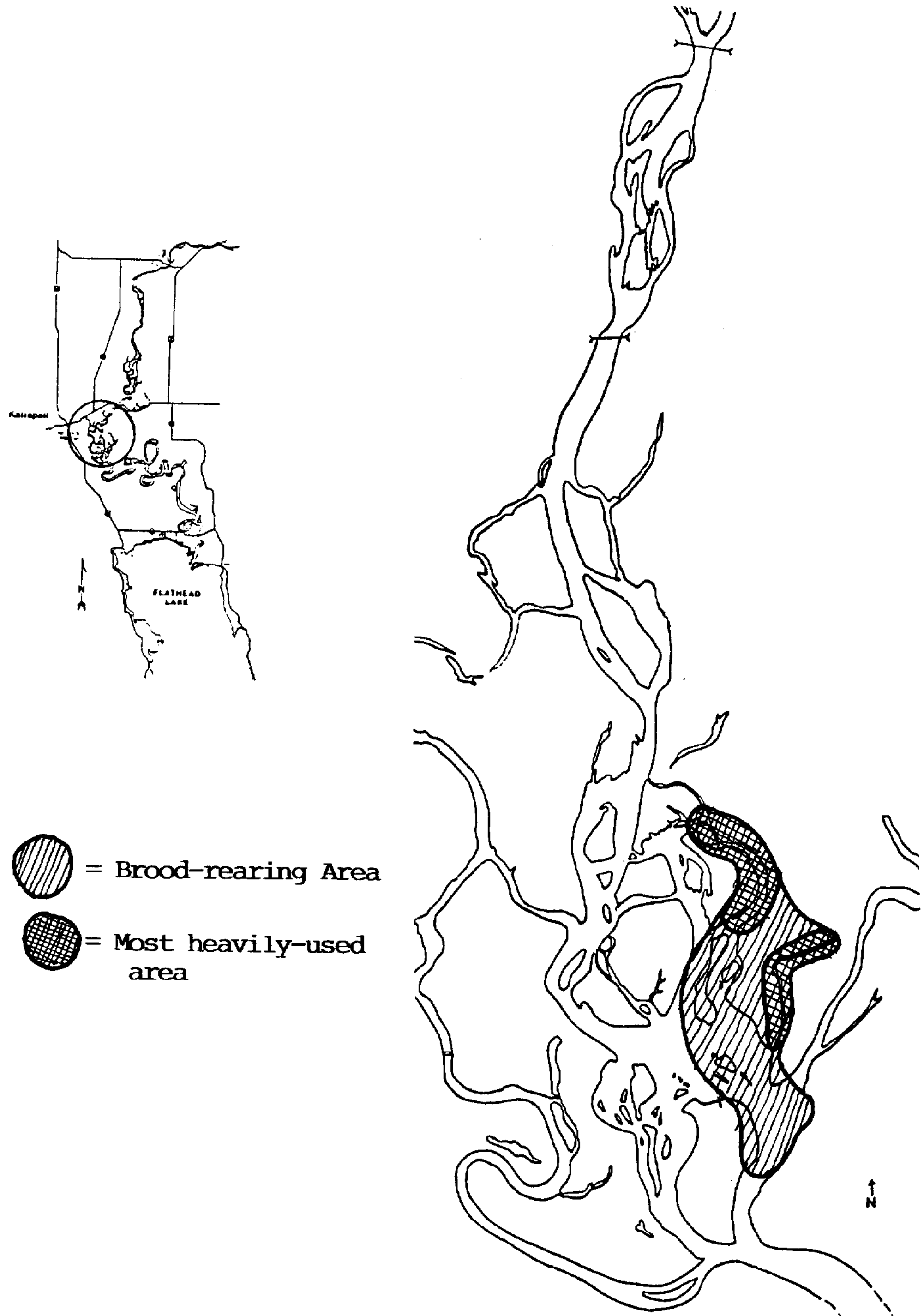
APPENDIX K

Known Canada goose brood-rearing areas, northern Plathead Valley, Montana, 1984-1987 (continued).



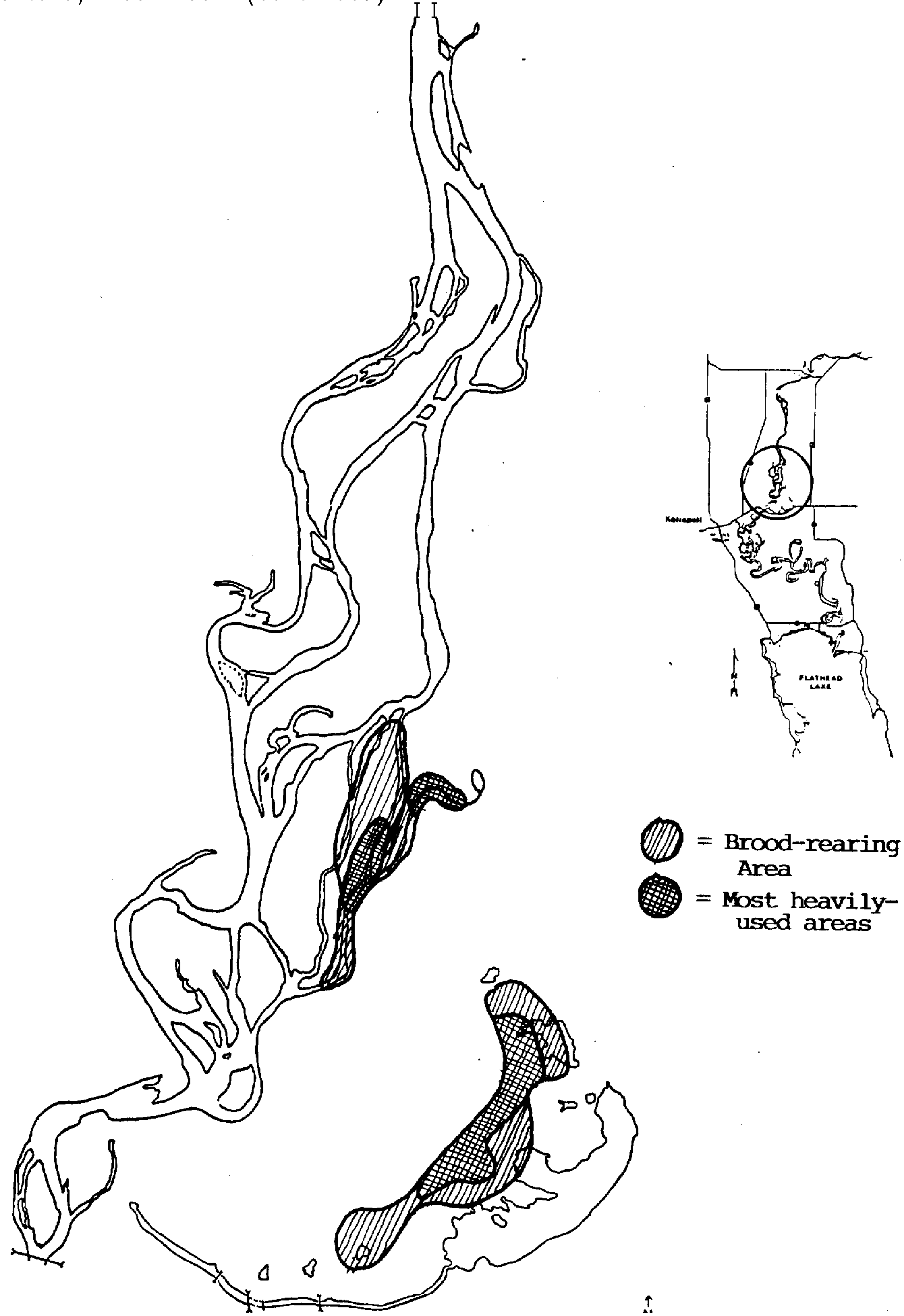
APPENDIX K

Known Canada goose brood-rearing areas, northern Flathead Valley, Montana, 1984-1987 (continued).



APPENDIX K

Known Canada goose brood-rearing areas, northern **Flathead** Valley, Montana, 1984-1987 (continued).



APPENDIX L

Percent cover and frequency of plant species found in Canada goose brood-rearing areas, northern Flathead Valley, Montana. Sampled sites were combined into two cover types: pasture (grazed) or herbaceous sites.

CODE	SPECIES	PASTURE SITES % cover (freq.)	HERBACEOUS SITES % cover (freq.)
AQUATICS/SEMI-AQUATICS			
A007	Hippuris vulgaris		1.0 (.08)
A012	Polygonum amphibium		16.0 (.20)
A023	Sagittaria cuneata		2.5 (.10)
FORBS			
F001	Achillea millefolium		0.2 (.10)
F007	Anthemis arvensis	3.5 (.05)	
F011	Capsella bursa-pastoris	1.8 (.09)	
F013	Cerastium sp.		2.2 (.14)
F014	Cerastium viscosum	1.5 (.08)	
F016	Cirsium arvense	10.1 (.18)	8.5 (.10)
F017	Cirsium sp.	2.3 (.18)	39.0 (.20)
F023	Epilobium sp.		.5 (.04)
F024	Equisetum spp.	2.8 (.31)	21.8 (.70)
F025	Erigeron philadelphicus		1.0 (.08)
F026	Galium boreale		2.0 (.06)
F028	Habenaria hyperborea		0.2 (.02)
F029	Hackelia deflexa	0.8 (.04)	
F032	Medicago lupulina	16.3 (.69)	11.0 (.20)
F036	Osmorhiza sp.		0.2 (.02)
F037	Plantago major	5.7 (.70)	8.1 (.22)
F039	Potentilla sp.	1.4 (.15)	
F040	Prunnela vulgaris	22.3 (.21)	2.0 (.06)
F041	Rumex sp.	5.5 (.04)	
F047	Sonchus sp.		4.8 (.08)
F049	Galium trifidum		0.2 (.02)
F051	Taraxacum officinale	10.2 (.88)	8.0 (.14)
F053	Trifolium repens	10.8 (.49)	5.2 (.22)
F054	Verbascum sp.		0.2 (.02)
F056	Viola sp.	17.5 (.01)	2.2 (.08)
F057	Mentha arvensis		1.5 (.14)
F058	Geranium pusillum	1.5 (.08)	
F062	Trifolium sp.	21.8 (.13)	
F063	Chrysanthemum leucanthemum	1.8 (.03)	
F066	Aster sp.	9.7 (.23)	
F067	Myosotis laxa		5.5 (.14)
F070	Cardamine oligosperma		0.2 (.02)
F071	Lycopus uniflorus		1.8 (.04)
F072	Hypericum perforatum	4.5 (.04)	

APPENDIX L

Percent cover and frequency of plant species found in Canada goose brood-rearing areas, northern Flathead Valley, Montana. Sampled sites were combined into two cover types: pasture (grazed) or herbaceous sites (continued).

		PASTURE SITES	HERBACEOUS SITES
CODE	SPECIES	% cover (freq.)	% cover (freq.)
F101	Unknown		0.2 (.01)
F102	Unknown	9.8 (.13)	
F103	Unknown	0.2 (.01)	
F107	Unknown	0.8 (.04)	
F108	Unknown	2.5 (.06)	
F110	Descurainia sophia	0.8 (.04)	
GRAMINOIDS			
G001	Elymus sp.	0.2 (.02)	1.5 (.02)
G002	Agrostis alba	65.3 (.60)	26.7 (.52)
G004	Agropyron repens	26.4 (.30)	18.1 (.22)
G005	Agrostis sp.		1.2 (.10)
G008	Beckmannia syzigachne		0.2 (.02)
G009	Bromus sp.		20.5 (.10)
G015	Carex spp.	3.5 (.24)	24.8 (.40)
G016	Dactylis glomerata		4.5 (.22)
G020	Festuca sp.	6.0 (.08)	
G021	Glyceria sp.		1.5 (.02)
G023	Hordeum jubatum	1.4 (.12)	
G028	Juncus spp.	1.0 (.08)	45.5 (.20)
G029	Phalaris arundinacea		32.6 (.44)
G030	Phleum pratensis	4.5 (.06)	21.8 (.20)
G032	Poa pratensis	44.7 (.60)	33.0 (.20)
G037	Typha latifolia		3.0 (.04)
G039	Scirpus sp.	14.2 (.20)	.9 (.04)
SHRUBS			
so19	Symphoricarpus sp.	0.5 (.03)	6.2 (.10)
so20	Vaccinium sp.		0.2 (.02)
S023	Alnus incana		0.5 (.04)
S024	Vibernum edule		8.5 (.02)
S006	Crategus douglasii	0.2 (.01)	
S011	Populus anpustifolium		3.8 (.20)
S016	Salix rigida		2.0 (.16)
so17	Salix sp.		10.0 (.24)
S005	Cornus stolonifera		1.5 (.02)
so14	Rosa sp.		6.0 (.10)
S021	Populus sp.	4.8 (.16)	

APPENDIX M

Percent and (frequency) of plant species found in 1 m^2 circular plots used to sample herbaceous vegetation for each cover type.

Species	COVER TYPE[a] DFM	DFI	CF	CD	DSM	DSCW	SS	HERB
GRASSES								
Agropyron sp.	5 (50)	10 (75)	tr[b] (20)			tr (20)		
Agrostis alba		20 (100)				20 (100)		4 (50)
palustris						1 (20)		4 (20)
Sp.rostis			tr (5)		8 (20)			
Calamagrostis sp.					2 (30)	3 (30)		
Carex spp.			tr (15)		8 (70)	8 (40)		4 (30)
Dactylis glomerata		tr (10)						
Eleocharis palustris								8 (70)
Elymus sp.		4 (50)						
Festuca sp.			1 (15)					
Juncus sp.						1 (20)		
Poa sp.		2 (85)				13 (40)		1 (30)
FORBS								
Actea sp.	tr (10)		tr (15)					
Apocynum cannabinum					3 (20)			1 (20)
Asparagus officinalis		2 (15)						
Aster laevis						1 (20)		
Centaurea sp.		1 (10)						
Chrysanthemum leucanthemum						1 (20)		
Cirsium sp.	13 (60)				11 (40)	3 (30)		
Clematis		1 (25)						
Cynoglossum sp.	21 (100)							
Equisetum	7 (80)	tr (10)	1 (25)		tr (10)	12 (80)		58 (90)
Erigeronphicus						1 (30)		
Galium sp.	3 (50)		tr (5)					
Habenaria sp.					3 (20)			
Hypericum perforatum						1 (20)		
Mahonia repens			6 (40)	3 (20)				
Medicago lupulina		2 (15)						
Mentha arvensis						1 (30)		
Plantago major						tr (10)		1 (40)
Smiliacina sp.		tr (10)	tr (5)	1 (20)				
Solidago sp.		6 (50)			5 (30)	16 (90)		
Spirea betufolia			2 (10)					
Streptophus amplexifolia			tr (10)					
Tanacetum sp.					3 (20)	tr (10)		
Trifolium spp.		1 (30)						
Unknown #217							5 (50)	
Unknown #214					tr (10)			
SHRUBS								
Acer glabrum				21 (70)				
Betula occidentalis				2 (20)		tr (10)		
Cornus stolonifera	tr (10)	1 (5)			2 (40)			
Crataegus douglasii	tr (10)				tr (10)			
Populus trichocarpa						8 (20)	14 (80)	
Prunus virginiana		1 (20)		2 (10)				
Rosa sp.			9 (30)		tr (10)			
Salix exigua		2 (20)				42 (80)	tr (10)	3 (50)
Salix rigida						11 (50)		
Salix sp.					tr (10)	2 (10)		
Symphoricarpus sp.	1 (20)		10 (25)	24 (80)				

a/ DFM - deciduous forest (mature); DFI - deciduous forest (immature); CF - coniferous forest; CD - mixed conifer/deciduous forest; DSM - dense shrub mixed types; DSCW - dense shrub cottonwood/willow; SS - sparse shrub; HERB - herbaceous.

b/ tr = trace, less than 1 percent cover.

APPENDIX N

Summary of vegetation characteristics for cover types used to describe existing habitats available to Csnada geese in northern Flathead Valley, Montana.

VEGETATION PARAMETER (%)	COVER TYPE[a]						
	DFM	DFI[b]	CF	CD	DSM	DSCW	SS	HERB
Overhead cover density	98	95	98	99	95	15	--	--
Grass cover	31	39	2	1	23	36	0	17
Forbcover	5	14	3	11	18	40	0	64
Shrub cover	tr[c]	3	39	--	3[d]	60	14	3
Tree/shrub cover by species:								
larix occidentalis			7					
Picea sp.				3				
Pinus ponderosa		5						
Populus trichocarpa	70	58	3			40	25	
Pseudotsuga menzies		tr	64	30				
glabrum			45	25				
Alnus sp.					13			
Amelanchier alnifolia			12	8				
Betula ntalis				35		3		
Comus stolcnifera	60			13	85			
Juniperus scopulorum		3	tr	6				
Physocarpus malvaceus			5	8				
Prunus virginiana		tr	9	18				
Rosa sp.		7	5					
Salix exigua						38		
Salix rigida						25		
Salix spp.					10	8	11	
Shepherdia canadensis		tr						
Symphoricarpus sp.			58	I.3				

a/ DFM - deciduous forest (mature); DFI - deciduous forest (immature); CF - coniferous forest; CD - mixed conifer/decisuous forest; DSM - dense shrub mixed types; DSCW - dense shrub cottonwood/wilow; ss-sparse shrub; HERB- herbaceous.

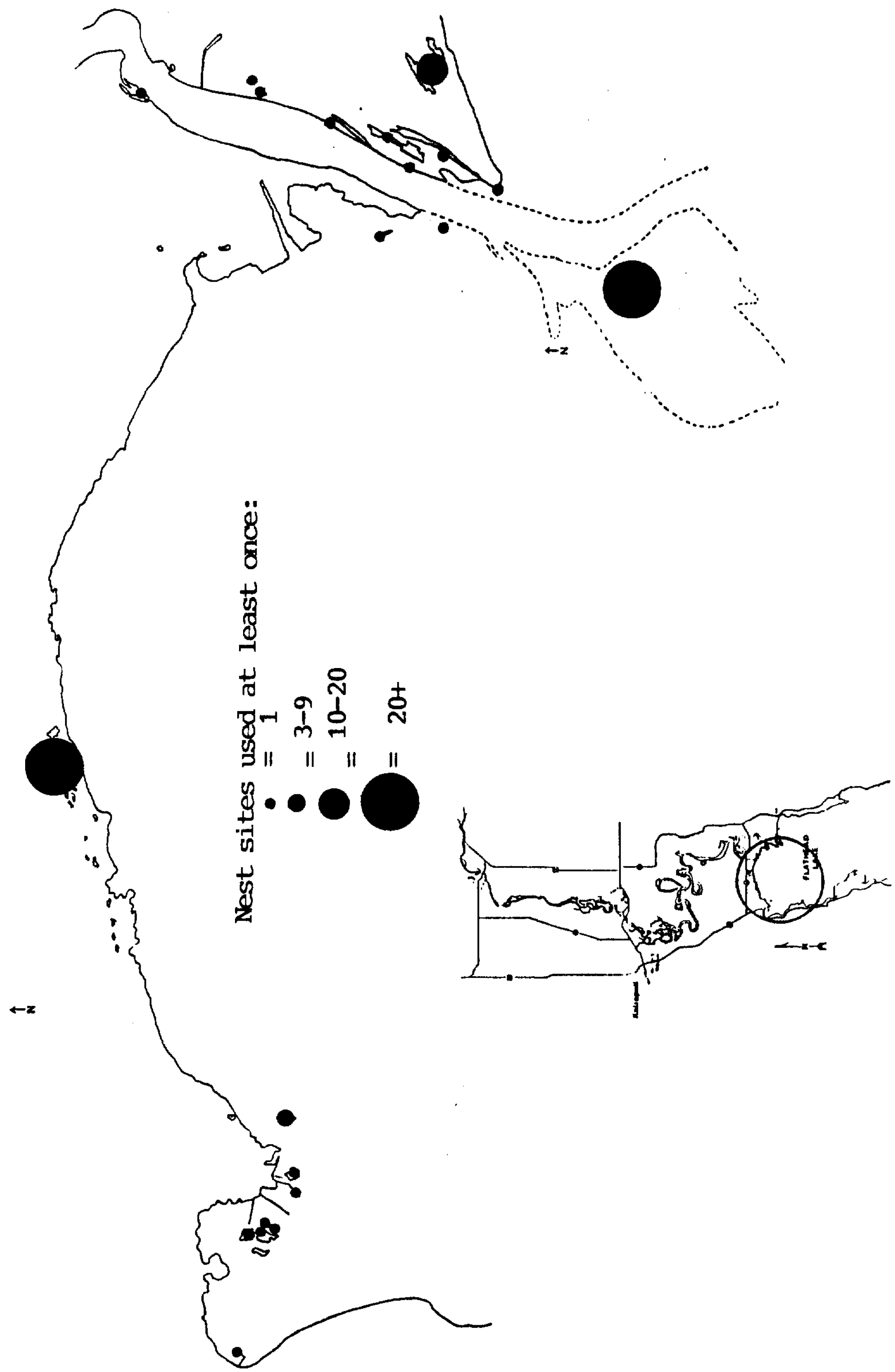
b/ Data for DFI and CF vere averaged from two sample sites. Allothertypes represent one sample site.

c/ tr = trace, less than 1 percent cover.

d/ Percent shrub cover for DSM reflects only saplings or seedlings less than 1 m tall.

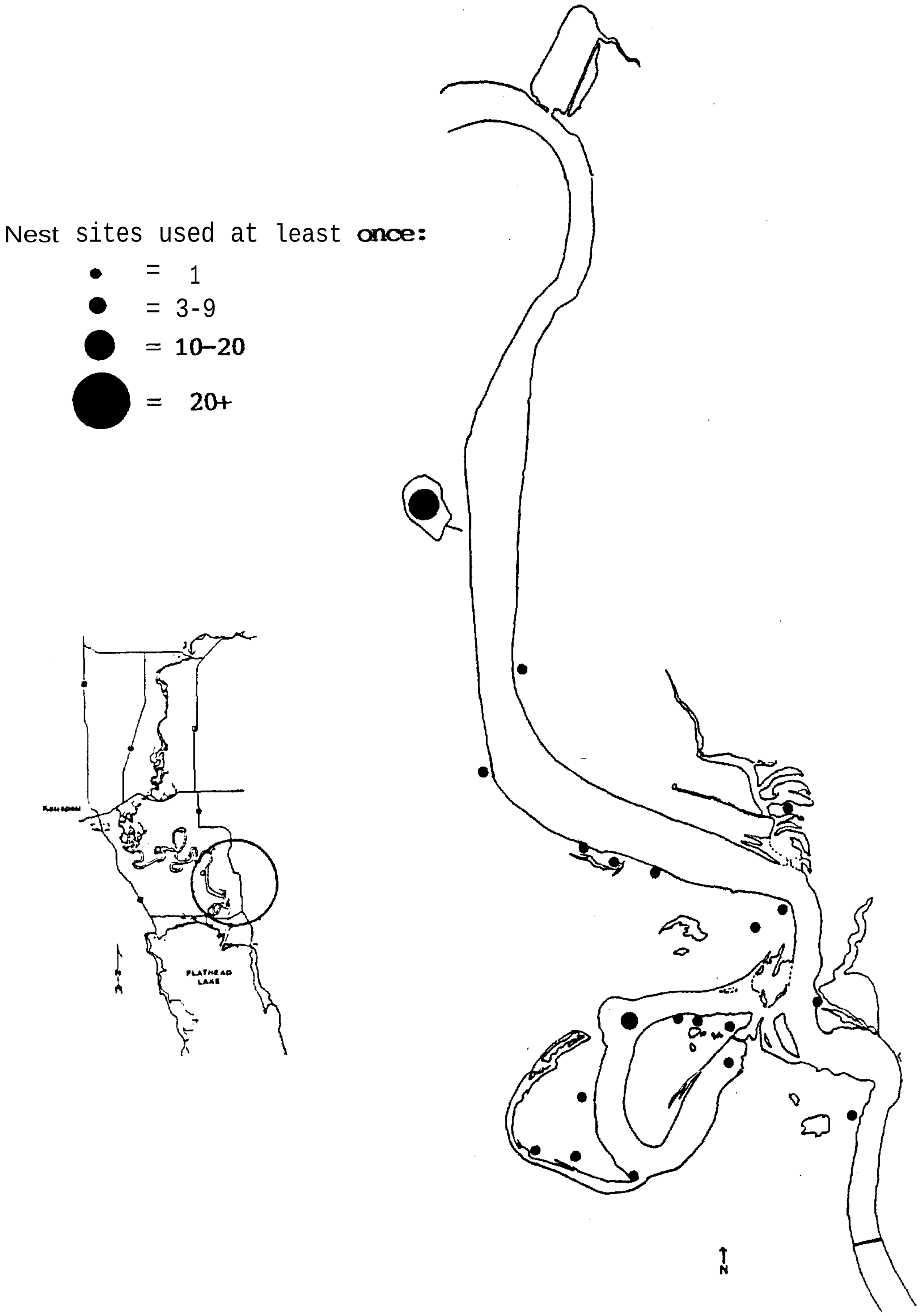
APPENDIX O

Known Canada goose nesting areas, northern Flathead Valley, Montana, 1984-1987.



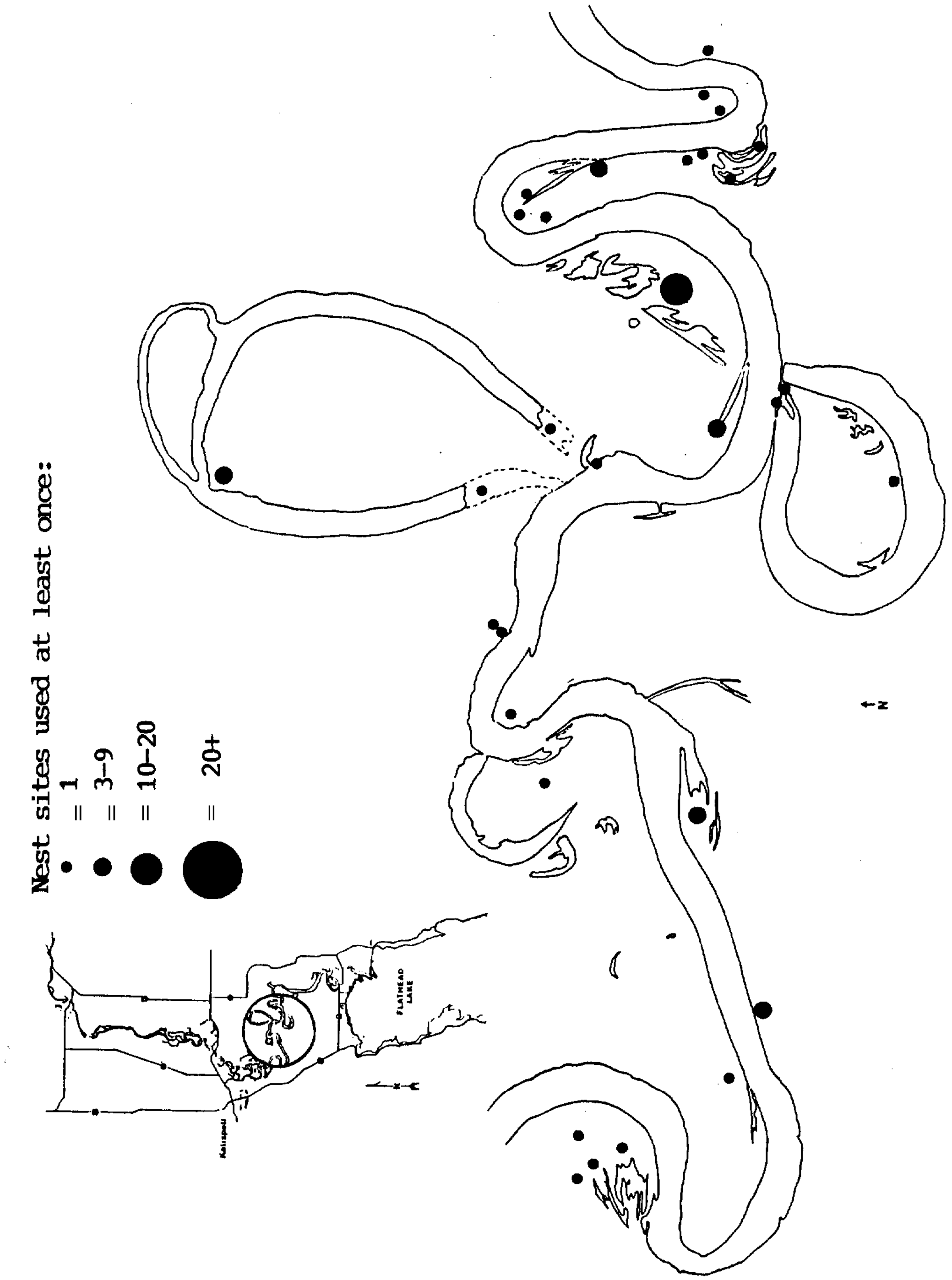
APPENDIX O

Known Canada goose nesting areas, northern Flathead Valley, Montana, 1984-1987 (continued).



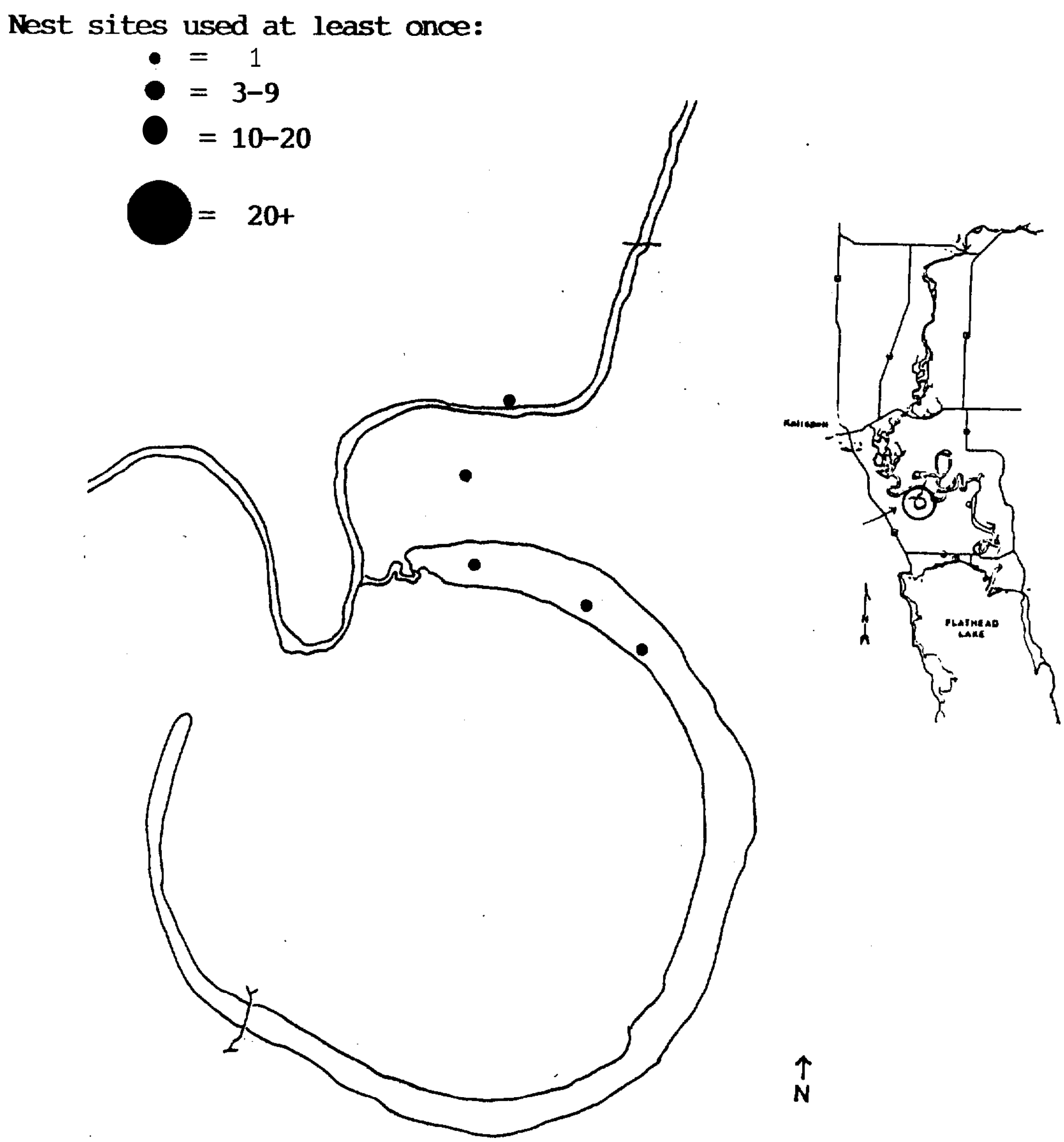
APPENDIX O

Known Canada goose nesting areas, northern Flathead Valley, Montana, 1984-1987 (continued).



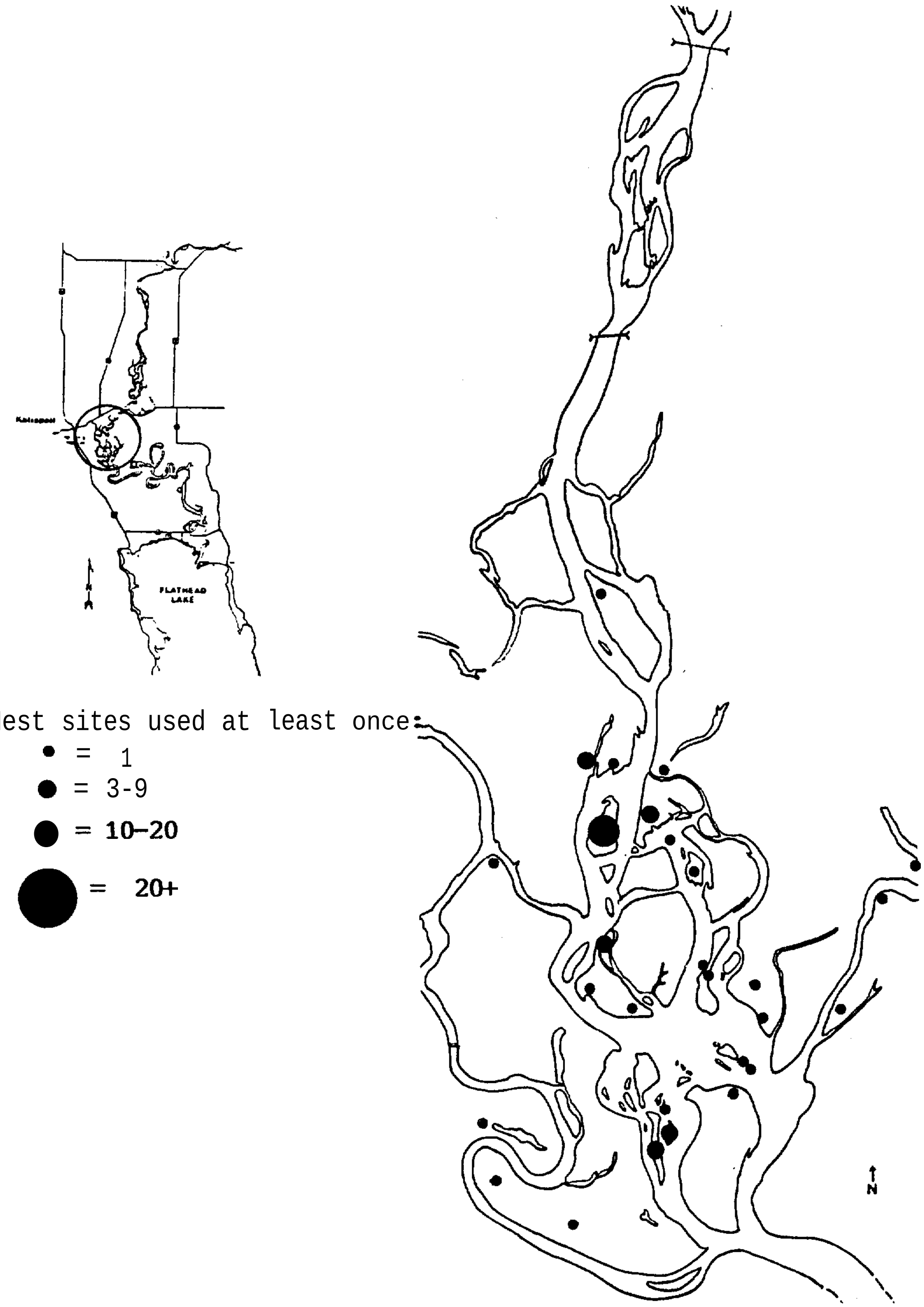
APPENDIX0

Known Canada goose nesting areas, northern Flathead Valley, Montana, 1984-1987 (continued).



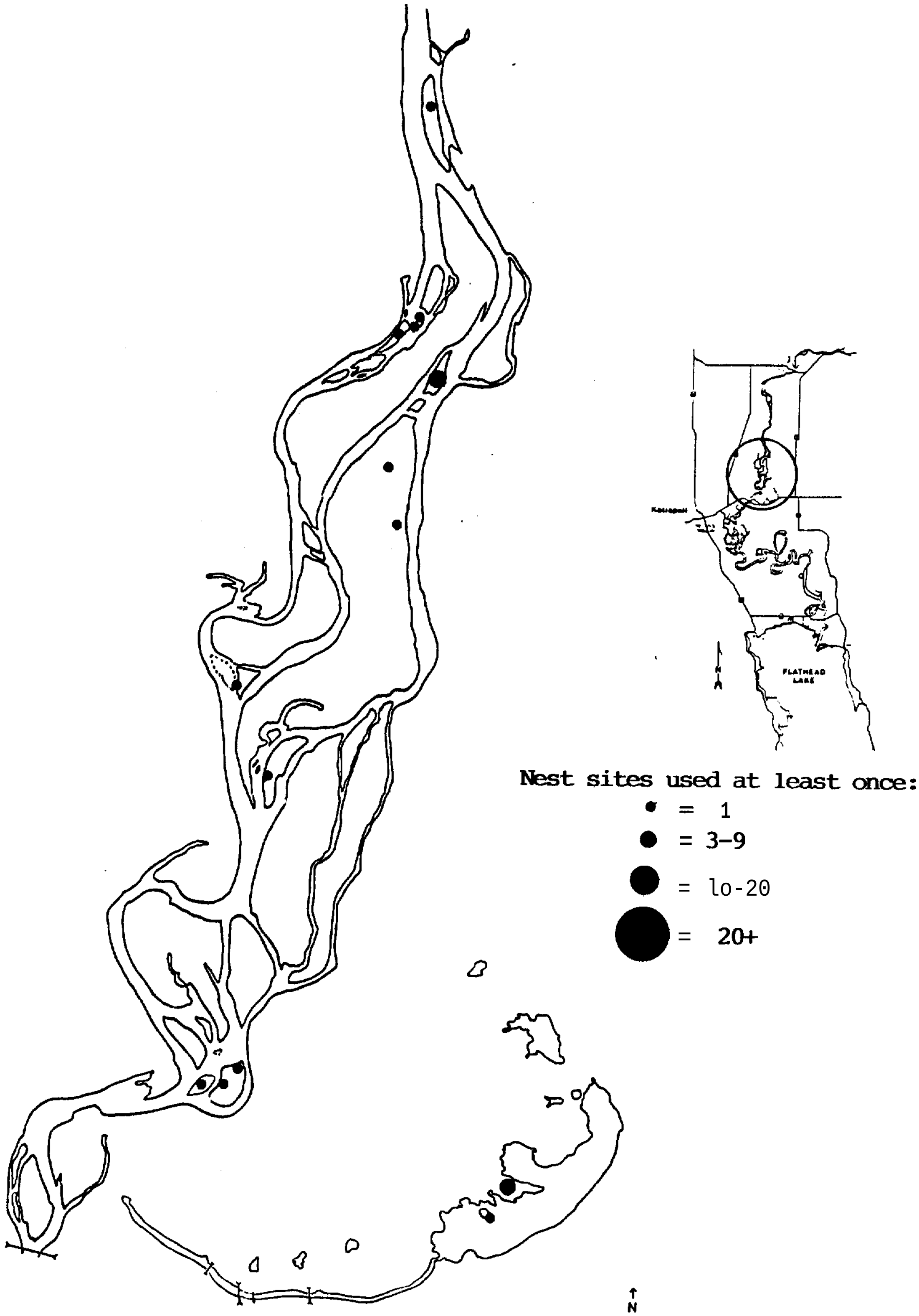
APPENDIX O

Known Canada goose nesting areas, northern Flathead Valley, Montana, 1984-1987 (continued).



APPENDIX O

Known Canada goose nesting areas, northern Flathead Valley, Montana, 1984-1987 (continued).



APPENDIX O

Known Canada goose nesting areas, northern Flathead Valley, Montana, 1984-1987 (continued).